JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Institution of Chemical Engineers, of the Coke Oven Managers' Association, and of the Federal Council for Chemistry

VOL. 52 LONDON, APRIL 28, 1933 No. 17

EDITORIAL

The Transmutation of the Elements

WE are all of us familiar with the constituents of an atom, the electron, or unit of negative electricity with a mass of less than a thousandth part of the mass of a hydrogen atom, the proton or positively charged body of mass 1, the neutron with mass 1 and no electrical charge, and the α-particle with mass 4 equal to the helium atom and positively charged. From a recent lecture delivered by Lord Rutherford to the Royal Institution it seems probable that we may shortly become acquainted with the unit of positive electricity, with a mass very much less than unity. Lord Rutherford called attention to his own experiments made so long ago as 1919, when he bombarded nitrogen with α-particles; these are occasionally captured by the nitrogen nucleus and expel a proton leaving a new nucleus with a mass of 17. Last year Chadwick bombarded beryllium with α-particles expelling protons and leaving a nucleus with a mass of 12. Feather showed that nitrogen can be bombarded with neutrons, expelling α-particles and leaving a nucleus with a mass of 11; oxygen behaves similarly: if it is bombarded with neutrons, α-particles are expelled leaving a nucleus with a mass of 13. Last year also Cockcroft and Walton showed that if lithium is bombarded with protons the lithium atom of mass 7 absorbs the proton with mass 1 and is converted into two α-particles each with a mass of 4. The apparatus of Cockcroft and Walton in Cambridge produces a steady potential of 800,000 volts and very much higher voltages are obtained by Lawrence in the University of California. But in the earth's atmosphere there are electrons and protons with voltages from 200 million to 2000 million volts and from the experiments of Anderson in Pasadena and Blackett and Occhialini in Cambridge it seems that these are very efficient in causing the transformation of nuclei. Lord Rutherford states that strong evidence has been obtained of the production of a new type of positively charged particle which has a mass small compared with that of the proton, and this may prove to be the positive electron, the counterpart of the well-known negative electron of light mass. Further information on this extremely interesting topic is eagerly awaited.

On Being a Chemist

The Fellows and Associates of the Institute of Chemistry are to be congratulated on having received an East⁻⁻ gift of an unusual character: we refer to Prof. Findlay's recent lecture on "Science and the Community" in pamphlet form. It has seldom been our fortune to read a chemical tract which is more inspiring or written in a more gracious and modest manner and we would earnestly commend it to the widest possible circle of readers. The theme is not a new one but its emphasis is always desirable and never more so than at the present; it contrasts the true spirit of science with its materialistic expression, it calls us back from processes and patents to follow the beckoning finger of the spirit of truth and knowledge. As an industrial society it is one of our objects to supply our members with the latest and most complete technical information of the progress and happenings in all branches of applied chemistry and to that extent we are materialistic, but we are equally concerned to bring chemists together in a co-operative effort and in comradeship and to advance the three great primary aims or ends in human nature to which Prof. Findlay alludes. Our ideal would fain be a journal equally devoted to the humanities and the facts of chemistry; but we, like the rest of the world, must cut our cloth according to our purse. If we had the support of every chemist, of everyone in any way associated with our science, how much more could we do; but though the annual subscription to the Society is but the equivalent in cost of a packet of cigarettes per week, there are many who prefer to worship the goddess "Nicotine." Chemistry is one of the greatest of the professions but if it is to maintain its position, then the maximum number of chemists must aim at being men with three-storey intellects, as Oliver Wendell Holmes puts it, men who have some aim beyond their facts, can do more than compare, reason, generalize, who indeed can idealize, imagine, predict. Prof. Findlay is especially profound in his references to the part which men of science may claim to play in the general life of the community: it is not always recognized by chemists that human nature is not amenable to the laws of exact science. It seems to us most urgent in the present crisis that men of science should concern themselves with the communal life partly to counteract the influence of the self-seeking politician, but still more to help in solving what is perhaps about to be the world's most urgent problem, namely the proper use of leisure. It is, unfortunately, apparent that there is not enough work for all those, male and female, who need it either now or in the near future, and it may be that a solution of the problem can be found along the lines of sharing the available work: this will involve

shorter hours and more leisure for all. The success of such a labour-sharing scheme will depend upon whether proper and intelligent use is made of the leisure: if this is devoted merely to amusement it will fail, but if the public can be guided to make an intelligent use of their spare time, the country can return to prosperity. Here is where the man of science has an opportunity; as a class he is characterized by the use he makes of his leisure and he can perhaps by precept and influence teach others to do the same. We have previously emphasized just as Prof. Findlay does that the price of industrial efficiency may be too high when it entails the loss of individual freedom, the suppression of individual responsibility, and the conversion of man into a machine. Britons to-day are disciplined but not so disciplined as this, and the true man of science must lead them to remain critical, independent, and free at the same time as they co-ordinate their efforts to obtain the maximum efficiency. It is on these lines that we must arrange our own house and the world around it.

Prosit Amerika!

Mr. Punch, with his usual alertness, seizes the situation, in representing Neptune Uncle Sam welcoming our Prime Minister with a mug of beer! Note the mug—no mere glass. The mug disposes of all nonsense of brightness, the craze of the industry to-day, which is fast leading it to its downfall. We could have wished that Toby's guardian had gone a little further and pictured Mr. MacDonald, also with a mug, drinking "*Prosit Amerika!*" The fleece at which he points is since fallen from Liberty's hands and he may need support to carry him through. Beer, we believe, has been spoken of in Manchester as "the one safe drink the world over." Although the amount of "safety" left in it is now perhaps "*verschwindend klein,*" it is yet safer than "near beer" (though that perhaps would be its proper definition) and we need have no fear for our envoy's health on the liquid side. Familiarity breeds content. Already we are told that beer has qualities not usually placed to its account: it reduces the danger of drunkenness. Great are the uses of adversity, when it thus leads to virtuous admissions. Would that our old friend Dr. Wiley were alive, that we might raise our mug and drink to the arch old artist's return to sanity. We do so in spirit and to that of all good American chemists.

A Lesser Art

We had before us recently the British Colour Council's Autumn Colour Cards of 1933, in which Imperial Chemical Industries, Ltd. have set out for our admiration the Council's selected colours for woollen, cotton, and silk fabrics. It was perhaps a little difficult to think of them as *autumn* colours, when the first rather premature burst of spring was in the air, with the grass in Finsbury Square taking on a most jubilant freshness, and the sun streaking the trees that were acquiring their new leaves. The Council has to get to work early, for the colour-user must take count of the seasons and be well prepared for them. Here there were greens, blues, browns, having on the whole, we thought, a rather sombre quality appropriate to autumn but also a decided attractiveness. Looking at them we wondered if the condemnation which the æsthete often aims at the industrialist was in this case merited. Fifty years ago William Morris said that dyeing was no longer an art but a trade, suggesting that all the merits of craftsmanship had been subjugated to the attainment of success in commerce, and so was disposed to belabour the civilization "which for the last three hundred years has greeted with enthusiasm every invention which tends to make its clothes and dwellings uglier and more inconvenient." Morris lived in a period that placed no great count on artistic achievement; when too industry was beginning to find that it had sturdy legs and could run with them; when man had perhaps turned aside some of the more worth-while things of life to concentrate on riches rather than wealth. Perhaps 1933 can show no very great reformation from this state of affairs, though it is to be hoped that out of the tangle of complexity into which industry has become tied in the last few years there will be sorted out some threads of clear thinking, logical reasoning, foresight, and appreciation of the things of merit. One can now understand some of the bitterness of William Morris as he watched the passing of the craftsman, for he foresaw many of the consequences, and though many of his visions have since materialized, it is possible that they were then less inevitable than they now seem. To return to the Autumn Colour Cards—what now, we wonder, would Morris think of the "Rose Dawns," "Lacquer Reds," "Victorian Madders," "Shore Beiges," and the rest? Were he again to write of "the lesser arts of life," he would probably have something to say of the use of such fanciful names, although it must be admitted that they have the merit of descriptiveness in a world that has not much time to spare, whilst "Varsity Blue" is less prosaic than "B.163," and certainly more manageable than "3·8% Lissamine Navy FK—2·8% Lissamine Navy AN—0·6% Lissamine Violet 2RS." Morris gave credit to Perkin and his successors for their skill, patience, and capacity for research, but deplored the fact that the work had led to the production of "colours hideous in themselves," whereas, he said, "all the old dyes were beautiful colours." His criticism was perhaps a little premature, for the industry was in its early years, but he was so convinced of the difference between the old and the new as to draw a line of distinction between the dyer and "the scientific person." He condemned the new colours for their being as fugitive as the older ones were stable, whilst of their lack of fastness he said that their fading was "a change into all kinds of abominable and livid hues." Things have changed since then and, we think, for the better. Morris would have been the first to admit of the change, for some of his major arguments will no longer hold water. The dye-manufacturing industry in this country may have been built up on the quest for profits, but in the pleasant shades it has given us, with their fastness, and their substitution of brightness and variety for drabness and sameness, it has not left us entirely without profit. The lesser art has developed; it almost deserves promotion to another class.

CORROSION FUNDAMENTALS*

By C. E. BEYNON, B.Sc.

It has for some considerable time been realized that he corrosion of metals is a subject of intense interest o the practical man who has to rely on the prolonged ervice of some one metal or another both in his industrial ind domestic life. The very serious nature of this probem has been brought out by the recent researches of Sir Robert Hadfield, who calculated that the annual cost of the replacement and repair due to the corrosion of iron ind steel alone is of the same magnitude as the annual ost of the world's armaments, a sum in the region of ne hundred million pounds. The corrosion of metals ias therefore been compared to what may be termed the orrosion of mankind. It cannot be too strongly mphasized that it is the essential duty of each and all o take as prominent a part as possible in the difficult ask of reducing steadily both these forms of wanton vastage

While in the past numerous but rather haphazard attempts have been made to combat the problem of netallic corrosion, it is only within the last ten years or so that methods which may be called really scientific iave been applied in an endeavour to overcome the lifficulties which constantly face the users of almost all netals and alloys. It is proposed, in this short paper, o deal briefly with the more academic side of the roblem in the light of the recent researches, in the hope hat the results of this recent work will enable us to pply more efficient methods of corrosion prevention han have been possible in the past; this aspect of the roblem is considered more particularly as so great an uthority on the study of metals as Sir Harold Carpenter ias thought fit to emphasize the fundamental importnce of laboratory experiments carried out under strictly defined and simple conditions." Before the roblem can be attacked in a really efficient way it is ssential that we should understand its nature. We nust determine the cause of corrosion before we can ope satisfactorily to prevent it. This is all the more ecessary in view of the fact that within recent years conomic reasons have dictated the use of more easily orroded metals, *e.g.*, iron and steel, under more corrosive onditions, such as the increased sulphur dioxide content f the atmosphere due to the widespread burning of coal s a fuel, the noxious fumes which are evolved from ndustrial chimneys and the tendency towards the ollution of industrial rivers and streams.

Corrosion may be roughly divided into two types. The first type is that which occurs in the absence of an lectrolyte; the oxidation of metals at high temeratures is an example of this. The second type is hat for the occurrence of which the presence of an lectrolyte is always necessary. Almost all forms of quid corrosion come into this second class. These two ypes will be briefly discussed in the order given, the one hich occurs in the absence of an electrolyte coming rst. When a metal such as copper is heated in pure air he surface shows a series of colours due to the interrence of light by the thin oxide films formed on the surface of the metal. The manner in which these interference tints are produced is shown in Fig. 1. Here is illustrated the effect of the combined reflexions from (1) the oxide film surface and (2) the underlying metal surface of an incident beam of light of a definite wavelength. In case (*a*) the reflected rays (1) and (2) reinforce each other while in case (*b*) the two rays interfere. Whether the rays will interfere depends upon the thickness of the film. When white light is incident on a film covered metallic surface it is found that the thinner the film the shorter are the waves cut out. Thus we have the lower the temperature of surface oxidation the thinner the film, and the thinner the film the shorter is the wavelength of the light cut out, or absorbed; the thinner films therefore cut out the shorter-wave blue rays from the spectrum, and the surface hence appears yellowish brown. As the oxidation temperature rises the surface colour changes to brown, rose, bright blue, pale blue, greenish silver to silver, and then the series starts again. It is not necessary to develop this aspect further other than to remark that although interference colours do not appear below, say, 200 deg. C., this must

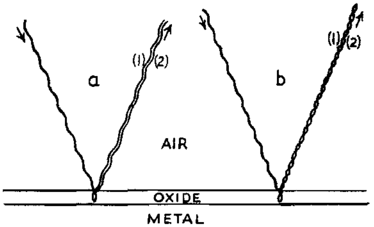


FIG. 1

not be taken to mean that no oxide films are present at these lower temperatures. Here the rays absorbed by the film are too short to have any optical effect. That such films do exist has been shown by Tronstad, who developed a delicate optical method of observing them, and Vernon, who devised a sensitive microgravimetric means of weighing them. It may be noted here that suitable steps can be taken gradually to cut down the thickness of the heavier oxide films, when it is found that the surface shows the same interference tints only the order of the colours is the reverse of that already given.

Some metals and alloys offer quite a considerable resistance to the formation of heavy oxide scales, aluminium and special chromium steels being particularly efficient in this respect. It may be safely assumed that this is due to the superior protective powers of the films formed thereon. Oxide films may have good or bad protective powers. When protection is good only a thin invisible film is needed, while bad protection means increased accessibility of oxygen to the heated surface, which, of course, results in further oxidation. If the protective film is broken by abrasion or any other means then the underlying metal is liable to further attack, and this in some cases may become intense. Aluminium,

* Read before a joint meeting of the South Wales Section of he Society and the Institute of Chemistry, on February 17, 1933.

for example, is a very reactive metal which is normally encased in an equally protective oxide skin. Amalgamation, either by contact with mercury or with solutions of mercuric salts, is able to loosen this skin and expose the metal, which reacts violently with the oxygen of the air and flakes of aluminium oxide are rapidly produced. It is reported with some regret that this identical phenomenon once had the most disastrous results. A small mercury thermometer was accidentally broken in a large aluminium vat in a brewery. This resulted in complete perforation of the vat walls in a remarkably short space of time.

It has long been known that the treatment of a metal with an oxidizing agent such as concentrated nitric acid, potassium dichromate, etc. usually renders the metal curiously inert or "passive," and it was thought that this passivity was due to the protective action of a thin oxide film formed on the surface of the metal. This view did not, however, receive general acceptance till Ulick R. Evans actually isolated the protective films responsible for the passivity of the treated metal. Evans was able to do this by several methods, the nature of which need not be dealt with here, but the principle of which lay in the dissolving away of the underlying metal while leaving the oxide film intact. The actual existence of these ultra-thin protective films, which are invisible when in contact with the metal, but which can be seen quite easily when removed by one of Evans' methods, has, therefore, once and for all, been experimentally proved. Thus when, *e.g.*, freshly ground iron is exposed to pure air the surface of the metal is oxidized yielding a film which is too thin to be seen when in contact with the metal, but which is sufficiently protective to prevent further access of oxygen to the metal surface underneath.

Before dealing with the second type of corrosion, *i.e.*, the one associated with the presence of an electrolyte, it will be well to give a brief résumé of the electrochemical principles involved in the study of this problem. When a lump of sugar is placed in a sugar solution there is a tendency for the sugar molecules to pass from the solid state into the solution, and this process will continue till equilibrium is reached. A somewhat similar state of affairs exists when a rod or sheet of metal is dipped into a solution of one of the salts of that metal. Here, however, the metal cannot dissolve as such, and what happens is that an interchange of ions takes place between the solid metal and the solution. If the solution is very dilute positive metallic ions tend to pass from the metal into the solution; if it is very concentrated the tendency is for the reverse to occur, *i.e.*, for positive metallic ions from the solution to deposit on the metal. For a given solution let us denote the ion solubility by S and the ion concentration by c. When S is greater than c positive metallic ions leave the metal and enter the solution. The surface of the metal thus acquires a negative charge, while that of the solution becomes correspondingly positive. The process continues till the negative charge on the metal is strong enough to prevent further positive ion solution. Equilibrium is attained and it is possible to measure the potential difference between the metal and the solution when conditions are such. The cases when S is less than c and when S is equal to c can be considered in the same way. *In all three cases an equilibrium potential difference is eventually set up. From the point of view of experimental convenience it has become customary to consider the cases of metals immersed in solutions of their salts of normal ion concentration*; the potential results obtained under these conditions when arranged in order constitute the electrochemical series. The arrangement of the more common metals on the basis of the electro-chemical series is as follows:

Positive end. Platinum, silver, mercury(ous), copper, hydrogen, lead, tin, nickel, cobalt, iron (ferrous), cadmium, zinc, aluminium, magnesium, sodium, potassium. *Negative end.*

The metals at the top of the series have positive electrochemical potentials and in their cases S is usually less than c. This means that they do not easily undergo corrosion. The metals at the lower end are strongly liable to corrode; in their case S is usually greater than c. The ions of the noble metals, viz., those at the positive end of the series, are more at home in the solid state; those of the reactive lower metals prefer to wander round in solution. If into a solution of a salt of a noble metal is dipped a more reactive metal, the ions of the latter rush into solution while those of the former aggregate into the solid state; an example of this behaviour is shown when a strip of iron is dipped into a solution of copper sulphate. As the more reactive iron passes into solution so is the more noble copper precipitated out.

We are now in a position to examine the case of the immersion in an electrolyte of two metals whose electrochemical potentials differ. As a concrete example we may take the immersion of rods of copper and zinc in a dilute solution of sulphuric acid. A glance at the electrochemical series shows that the attraction of ions into solution is greater for the metal zinc. Thus the zinc rod is deprived of more positive metallic ions than is the case with the copper. Hence the zinc becomes negative with respect to the copper. If the two rods are joined by means of a wire it is found that a current flows from the copper to the zinc, and that while this currrent flows zinc dissolves and hydrogen is formed on the surface of the copper. This is, of course, the basis of the simple cell, and as such is of academic interest only. It may be noted here that as hydrogen accumulates on the copper rod the metal tends to behave as a hydrogen rather than a copper electrode, and as hydrogen is nearer zinc in the series than is copper the e.m.f. of the cell falls. It can, however, be restored to its former value by adding an oxidizing agent to the solution. Such substances as potassium dichromate, potassium permanganate, etc. are able to remove the hydrogen as quickly as it is formed. This lowering of the potential of a cell by means of accumulated hydrogen is described as polarization and such substances as are able to prevent the lowering are termed depolarizers.

It is when the metals are in actual contact when dipped into the solution that this phenomenon of metal-couple corrosion becomes one of really practical importance. Under the conditions shown diagrammatically in Fig. 2 the zinc sends out ions into the solution and becomes anodic, while hydrogen is deposited on the

more noble copper. In an electroplating bath metal is deposited on the cathode and while this process is taking place ions are passing from the metal into solution at the anode. Thus, when ions are passing from a metal into solution the process is described as anodic, and this is

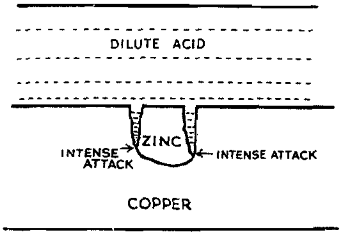


Fig. 2

the reason why in the case we are at the moment considering the zinc is said to be undergoing anodic solution. The resistance offered to the passage of an electric current by a solution is greater than that imposed by a metal. For this reason the current will tend to concentrate on that portion of the zinc adjacent to the copper and the corroding effect will naturally be greatest at the junction of the two metals. If the anodic zinc surface area is small the anodic current density will be correspondingly large. The attack will be concentrated on the small area of zinc and serious pitting will occur. The designer of a large American yacht was evidently unaware of the dangerous nature of this contact corrosion for he built the vessel largely of monel metal, a highly corrosion resisting alloy of copper and nickel, but used steel for the keel and rudder frame. As might have been expected, the monel metal became the noble cathode while the small steel parts suffered intense anodic attack. So intense, indeed, was this that the yacht had to be condemned before it had made a single voyage.

For corrosion of the contact type to have an appreciable and harmful effect the hydrogen deposited on the more noble component must be either evolved or removed immediately it is formed. Whether the evolution will occur depends largely on two factors. One is the acidity of the solution. When this is high, *i.e.*, when the p_H of the solution is low, the concentration of hydrogen ions is great enough to facilitate the removal of the gas as such. The other factor is the hydrogen overvoltage of the noble metal concerned. Hydrogen overvoltage may best be regarded as a measure of the reluctance with which a metal allows of the formation of hydrogen bubbles on its surface. When the acidity of the solution is low and the hydrogen overvoltage of the metal is high a thin layer of atomic hydrogen accumulates on the surface of the more noble metal component and when this layer completely covers the surface corrosion might be expected to cease. There is, however, another factor of some considerable importance which enters into the problem here. The effect of accumulated hydrogen has been previously mentioned when it was described as polarization. We saw, however, that the state of polarization depends for its existence on the absence of oxidizing agents or depolarizers. One of the most common depolarizers, *i.e.*, one of the substances able to facilitate the progress of this type of corrosion, is *dissolved oxygen*, the importance of which cannot be too strongly emphasized. In fact the corrosion of most ordinary industrial metals and alloys, viz., iron, steel, tin, lead, nickel, copper, brass, and bronze gives no rapid evolution of hydrogen unless a moderate concentration of free acid is present. The presence of oxygen is usually required when any of these undergo corrosion of a serious nature. It has been shown, therefore, that with regard to corrosion oxygen can behave in two distinct ways. Either it can help to produce an oxide film, protective or otherwise, or it can act as a depolarizer, *i.e.*, a hydrogen remover, and as such facilitate the continued corrosion of the less noble and more reactive part of the metal.

We are now in a position to discuss U. R. Evans' Differential Aeration Theory, which, it is hoped to show, is not quite as formidable as it seems. Evans was led by the results of some work done by Aston in 1916 to carry out an experiment in which two identical metal electrodes were immersed in the same potassium chloride solution, but while one of these electrodes was surrounded by a porous partition the other was exposed to the passage of a stream of purified air. The apparatus he used for this purpose is shown diagrammatically in Fig. 3. The electrode A was shielded, by means of the parchment partition B, from the stream of purified air which was bubbled over the other electrode C. The result of this, Evans' key-experiment, was that the electrode C which was exposed to the air was ennobled with respect to the other electrode A. This meant that

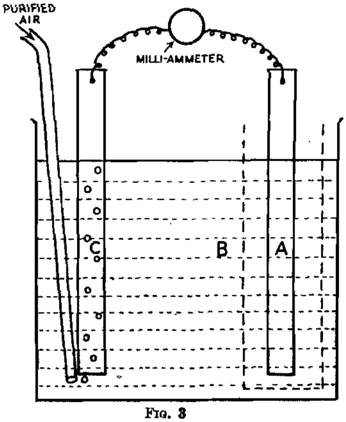


Fig. 3

the aerated electrode C became cathodic and protected, while the unaerated one A underwent perceptible anodic solution and, of course, showed considerable corrosion. The loss of weight undergone by the electrode A during the actual process was demonstrated by weighing.

If we compare this key-experiment with the simple cell, where copper and zinc are immersed in dilute sulphuric acid, we find that the unaerated electrode behaves like the zinc—it undergoes anodic solution, i.e., it corrodes—while the aerated strip resembles the copper in being cathodically protected and ennobled. Just as we have had to describe the simple cell as only of interest to the academic people, so we must regard U. R. Evans' key-experiment as, in itself, of little more than theoretical interest. We found, however, that the simple-cell principle became one of intense practical interest when the two metal components were in actual contact. The Differential Aeration Principle has therefore the most far-reaching and intensely practical results when one part of a metal has access to air or oxygen while another part of it is shielded from contact with these gases. Differential aeration, which amounts to differences in the rates of supply of oxygen to different parts of a metal surface, is responsible for one of the most serious forms of corrosion—a phenomenon known as pitting, *i.e.*, the rapid boring of small holes right through a metal sheet. This is most destructive and harmful in character, and may mean the condemning of an otherwise perfect and sound material. This is developed in rather more detail later.

It might be wondered how it is that differential aeration is able to bring about this phenomenon. Without going into any great detail it may be said that there are definite grounds for believing that the continuous supply of oxygen to a metal electrode surface is responsible for the formation of a protective oxide film, which hinders the passage of metal ions into the solution while it has little effect on the reverse process—*i.e.*, the deposition on the electrode of ions from the solution. The aerated electrode will, therefore, behave like a noble metal as compared with the unaerated one. The ions of the aerated part of the metal will seem to be more at home in the metallic state than those of the unaerated portion, which will prefer to pass into the solution. The potential difference which is set up between these two parts will then favour the passage into solution—in other words, the corrosion—of that part which has not direct access to dissolved oxygen. Aeration hinders the passage of ions into the solution from the aerated metal but considerably accelerates the attack on the unaerated zone by reason of the e.m.f. set up in the process.

This brings us on to the question of the relation between the porosity of metals and their corrosion, and here, as in some of the cases previously discussed, it will be best to consider a particular example. The necessary conditions are indicated in Fig. 4. A zinc surface is immersed horizontally below a shallow solution of sodium chloride in water. Since the solution is shallow, and the surface is exposed to the air, it is quite safe to assume that the concentration of dissolved oxygen in the solution adjacent to the main bulk of the metal is uniform. As the oxygen from such areas may be removed so it is readily replaced. This, however, does not apply to the conditions inside the small cavity illustrated in Fig. 4. It is clear that the rate of supply of oxygen to the surface inside this cavity will be considerably lower than that to the bulk surface which is more accessible to the atmosphere. According to U. R. Evans' Differential *Aeration Principle the surface of the interior of the cavity undergoes anodic solution, the zinc ions dissolving as zinc chloride, while the bulk surface outside becomes ennobled and cathodic, and as such is responsible for the deposition of sodium ions and the formation of caustic soda. Thus there are two surface solutions formed, one of zinc chloride and the other of caustic soda ; these solutions meet at the opening of the cavity and gelatinous zinc hydroxide is precipitated over the opening.* Thus, as a result of the corrosion, there is precipitated an insoluble body. Had the zinc hydroxide been formed at the seat of the corrosion it would probably have had the effect of slowing down the attack. It is formed, however, at some distance from the actual weak spot, and, as it is able to shield the interior of the cavity from the access of dissolved oxygen, it probably helps rather than hinders the corrosive attack. It may be repeated here that the smaller the internal area of the cavity and the larger the bulk area of the metal, the greater will be the rate of corrosive penetration.

Tammann and his co-workers have, by means of high pressure, been able to force a dye solution right into the interior of metallic specimens and to show that many

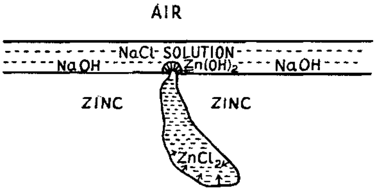


Fig. 4

so-called "sound" metals are threaded by channels of capillary size. It is thought that these channels follow the edges of the original crystal grains. In cast metals the capillaries run in all directions, but when the metal is rolled into sheet distortion occurs, and the cavities lie in the plane of the sheet. Apart from the accumulation of grease and dirt, there are strictly metallurgical reasons why it is that only a few of these capillaries open on to the surface. It has however been seen that cavity attack can be very severe indeed, and the presence of only a small number of such cavities opening to the surface can result in pitting, internal sponginess and, ultimately, in perforation. When the metal has been rolled into sheet the attack tends to pass below the surface in a direction parallel to that surface, enlarging the original capillary channels and causing the surface layer to peel off in flakes or rise in blisters. When a metal contains inclusions of slag and other foreign materials cavities are likely to follow the boundaries of such inclusions for several reasons, such as lack of adhesion between metal and inclusion surfaces, and differences in thermal (and, in worked materials, mechanical) properties between the metal and inclusion.

When a sheet of metal, such as, *e.g.*, zinc, is partially immersed in a vertical position in a solution of some such salt as sodium chloride, it is found that the location of the corrosion is in direct accordance with the Principle

of Differential Aeration. The changing conditions are illustrated in Fig. 5. A white corroded area first appears along the bottom of the plate (*a*), just the place where one would expect the oxygen to become exhausted first. This area becomes anodic, and zinc ions dissolve as zinc chloride. The upper portion of the sheet, *i.e.*, from the water level downwards, becomes cathodic and over its surface is formed a layer of caustic alkali. Where these two reagents meet zinc hydroxide is precipitated in the gelatinous form. The corrosion, however, is not confined to the bottom layer, for the cavity effect comes in even where the bulk surface is quite well aerated, and, in accordance with what has already been discussed, zinc hydroxide is again precipitated at the mouths of the cavities. When the sheet was horizontal the heaps of zinc hydroxide are unaffected, but when the sheet is vertical they flow slowly and surely downwards and the corroded area resembles that in (*b*). As the immersion time increases the appearance of the sheet gradually becomes that shown in (*c*), when no further change occurs. This type of corrosion, again, is of more than theoretical interest. A case has been reported where the metal walls of a gasometer suffered intense corrosion, leading to actual perforation, over that part of the metal

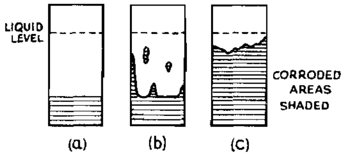


FIG. 5

which was more than 4 in. below the surface of the sealing water, while the 4-in. band just below the water-line showed no sign of attack.

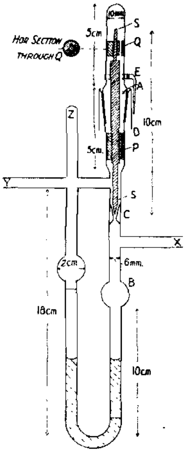
Finally, we may consider the effect of contact of a metal with foreign, non-metallic surfaces in the light of the Differential Aeration Principle. When a metal surface exposed to a liquid becomes partially covered with such foreign bodies as glass, stoneware, threads, cotton-wool, coke, paraffin-wax, etc., direct access of dissolved oxygen is hindered if not prevented. The areas of metal surface thus shielded become anodic, and suffer corrosion, while those parts of a metal surface which are quite clear are cathodically protected. In this connexion Bengough has studied the effect of sand, seaweed, etc. on the corrosion of marine condenser tubes, and his recommendation is the careful cleaning of these tubes at regular intervals using a relatively soft brush.

In conclusion it may be pointed out that it is only within the last ten years or so that corrosion problems have been studied in the scientific manner they merit. There is a tendency for the engineer to regard corrosion as a factor which relieves him of no little responsibility. Corrosion must be considered as a subject which borders chemistry, metallurgy, engineering, and physics, and one which offers opportunities for specialization to all with a good general knowledge of each of these four sciences.

A WIDE-RANGE VARIABLE GAS FLOWMETER

By B. W. BRADFORD, Ph.D.

A flowmeter was required capable of measuring rates of gas-flow with uniform accuracy over a wide range. The scale of the usual form of meter with fixed choke orifice is contracted approximately according to an inverse square root law, and its sensitivity increases rapidly with increasing rates of flow. This fact, together with the difficulty of reading small differences of pressure with accuracy on the normal type of U-tube oil manometer, restricts the useful ranges of such instruments to somewhat less than a ten-fold variation of flow-rate. The use of two or more choke tubes, each controlled by a separate wide-bore tap, gives greater flexibility, but the construction and selection of



suitably-sized orifices for a particular range of flow-rates is tedious, and such meters are seldom of general laboratory utility.

By employing a variable choke tube of the type described below, and working with a constant pressure difference between the two sides of the orifice, an instrument was evolved having a linear scale throughout a greatly extended range of flow-rates, and with a correspondingly improved sensitivity at low rates of flow. The use of an invariable pressure difference also gave the important additional advantage that the accuracy with which a stream of gas could be maintained constant was independent of the magnitude of the rate of flow throughout the whole range covered.

The instrument described in the following was designed for use with a constant pressure difference of 100 mm. of oil (density approx. 0·85). Its working range with this pressure difference was from 100 c.c. to 10 litres per min. (a 100-fold variation), and this range was

capable of extension when necessary at both the lower and the higher limits. The scale of flow-rates was linear from 100 c.c. to 8 litres per min., and a stream of gas passing through the meter could be kept at constant rate to within 1%.

The meter is shown in section in the diagram, in which the principal dimensions are indicated. With the exception of the metal spindle SS and the sleeves P and Q, glass was employed throughout, the rotation of the spindle requisite for variation of the choke aperture being provided by the ground joint A. The dimensions of the constriction at C must be adapted to the range of gas velocities which it is intended to cover: in the particular meter of which the performance is detailed above, the minimum constricted diameter was 1·5 mm., the aperture widening to 4 mm. in a distance of 4 mm. The external diameter of the tubing must be maintained at the constriction, and the thickened glass requires careful annealing in order to withstand the subsequent grinding-in of the spindle point. The orifice must be accurately centred and its axis brought into alignment with that of the ground-joint sections.

The gas enters at X and leaves at Y: the side tube Z is merely for convenience in filling the manometer and is sealed off when not in use.

The spindle SS may be constructed from $\frac{3}{16}$-in. brass or stainless alloy rod, its lower section being reduced in diameter sufficiently to pass through the tapped collar P. The spindle point is turned to a cone of pitch equal to that of the glass constriction, and is ground in with a fine grade of carborundum paste. A B.A. thread is suitable for the screwed section of the spindle.

The requisite mechanical connexion between the spindle and the rotatable section of the ground joint may be made either by means of a metal strip held in two glass side-tubes diametrically opposite one another, and engaging a long saw-slit at the upper end of the spindle, or more neatly, by the method shown in the figure. In the latter method (for which I am indebted to Mr. A. G. Quarrell), three flats are filed on the upper section of the spindle and pass through an equilateral triangular slot in the collar Q. The brass collars P and Q are turned, and if necessary tapered, to a good fit in their respective tubes. Shallow channels are cut round the outer surfaces of the collars, and filled with picein or other low-melting vacuum wax: the wax is cautiously melted after assembly of the apparatus, and on solidifying forms a secure joint between glass and metal. When desired, the metal parts may be platinized, *e.g.*, with "oil of platinum." If the flowmeter is to be used at reduced pressures, or with gases other than air, holes must be drilled as shown through the collars P and Q to allow free passage of gas.

The scale of flow-rates is marked on a brass cylinder D which is spun over at one end and attached to the rim of the female ground-joint section by cement or wax. The pointer E, constructed of stiff strip, is clamped to the rotating section of the joint. Provided that attention is paid to the elimination of backlash, the calibration of the meter remains constant. Where greater sensitiveness and robustness are required, as in a meter intended for use as a laboratory sub-standard, metal may be used throughout with the exception of the *manometer, rotation being allowed by a lapped or tapered ground joint. In cases where the use of oil as manometric liquid is undesirable, a variable aperture meter operated with constant pressure difference may be readily adapted for use with a sensitive mercury manometer of the differential air-bubble type.*

THE ELECTRON-NEBULA RATIO

By J. D. MAIN SMITH, Ph.D., B.Sc.

It is now more than a decade since Sir Ernest Rutherford showed that the inverse square law no longer holds when collisions between atomic nuclei occur within a distance of 3×10^{-13} cm., and pronounced that the nuclei of atoms are of the order 10^{-13} cm. in diameter. He emphasized the minuteness of the nuclei by citing the diameters of atoms at the order 10^{-8} cm. More recent work has confirmed these orders of sizes. Atoms are consequently one hundred thousand times larger than nuclei, or the atom-nucleus ratio is 10^5. The existence of a similar discontinuity in the dimensions of other material bodies does not appear to have been recognized. The diameter of the electron, however, is almost identical with the nuclear diameter, being 3×10^{-13} cm., according to the latest corrections of Sir J. J. Thomson's original calculation. The atom-electron ratio is consequently also of the order 10^5.

Commenting on the newer discoveries of Relativity and the Quantum, Sir Oliver Lodge, in "Atoms and Rays," states that "an abrupt discontinuity has made its appearance, replacing the smoothness by a jerk, the flow by a precipitous leap, the continuity by a succession of steps. . . . It probably does not occur to many to consider why matter should be distributed in spherical masses scattered about in space with immense intervals between them . . . only recently has it occurred to Eddington and other astronomers to speculate on the reason for this discontinuity in large scale matter; which may be said roughly *to imitate in a gross manner the atomic discontinuities of every visible and microscopic speck.*" The italics are mine, but the words are, like most of Lodge's utterances, pregnant with prophecy.

Astronomers have recently decided that the only kinds of material bodies outside the solar system are sun-stars, clusters of sun-stars, diffuse nebulæ, planetary nebulæ, and spiral nebulæ. All the spiral nebulæ appear to be replicas of our own spiral nebula, the Milky Way or Galaxy. They are all much of the same size and distance apart, and their structure is that of rotating, disc-like aggregates of clusters of sun-stars. So far as can be ascertained, the same types of sun-stars, and diffuse and planetary nebulæ occur in all of them. The diameters of but few are even approximately known. The neighbouring spiral nebula in Andromeda (M 31) is about fifty thousand light-years across. A light-year being six billion miles, the diameter is 3×10^{17} miles. Though the Milky Way is about six times this size, the majority of the two million known spiral nebulæ approximate in size to the Andromeda nebula. The electron diameter being 3×10^{-13} cm. or 2×10^{-18} mile, the ratio between nebula and electron is $1 \cdot 5 \times 10^{35}$. The seventh root of this number is indistinguishable from 10^5, whatever the exact sizes of nebulæ and electron, so long as they are

of the order quoted. The atomic sizes are of the order 10^{-8} cm., the mean diameter being near that of the sodium atom, $3 \cdot 6 \times 10^{-8}$ cm. or $2 \cdot 3 \times 10^{-13}$ mile. The ratio between nebula and atom is thus $1 \cdot 3 \times 10^{30}$. The sixth root of this number is indistinguishable from 10^5, which is the seventh root of the ratio between nebula and electron, and is also the ratio between atom and electron (or nucleus).

The bodies next in size to the spiral nebulæ are the diffuse and planetary nebulæ. Owing to their small size as compared with spiral nebulæ and the vast distance away of even the nearest spiral nebula (M 33 is 51×10^{17} miles from the Milky Way), little is known of the diffuse and planetary nebulæ in the spiral nebulæ. The diameters of the few that have been measured range from 0·01 to 0·05 parsecs. As the parsec is 3·26 light-years, the diameters of the diffuse and planetary nebulæ are from 0·2 to $1 \cdot 0 \times 10^{12}$ miles. These sizes are probably minima as they take no account of the spread of finer nebulosity, in some cases to several times the observed diameter of the nebula. The sizes are thus approximately one hundred-thousandth of the spiral nebulæ. It is also obvious that the ratios of the sizes of the planetary nebulæ to the atom and electron are 10^{25} and 10^{30} respectively. The fifth and sixth roots of these numbers are both 10^5, the ratio between atom and electron and also between spiral and planetary nebulæ.

In this connexion it must be remarked that the distances between adjacent sun-stars are also of the same order as the diameters of the diffuse and planetary nebulæ. In the galactic plane (the central or equatorial plane of the Milky Way disc) the star-clusters are flattened and the stars spread out to greater distances than in regions far north or south of the galactic plane. In some of the " globular clusters " lying near the poles of the Galaxy, the stars are a hundred times as densely packed as in the flattened clusters. Probably the average distance between adjacent stars is nearer a tenth of that for the flat clusters in or near the equatorial plane. The sun is only 60 parsecs north of the plane (pole to pole diameter is about 9000 parsecs), and the average may thus be set at about one-tenth of the distance of stars adjacent to our sun. Proxima Centauri is the nearest star to us at a distance of 25×10^{12} miles, and α-Centauri is scarcely further away at 26×10^{12} miles. The inter-stellar distance for adjacent stars in our Galaxy is thus between 2 and 3×10^{12} miles. This is almost identical with the diameters of the planetary and diffuse nebulæ, and consequently the inter-stellar distances are related to the diameters of the spiral nebulæ by the ratio 10^5. This approximate identity appears to suggest a clue to the unknown position of the planetary and diffuse nebulæ in the stellar evolutionary scale. These nebulæ would appear to be primitive suns before condensation to " giants " and " dwarfs " has set in. Certainly it is known that all the planetary nebulæ have central nuclei which are stars of the Wolf-Rayet type, *i.e.*, suns with nebular spectra.

The heavenly bodies next in size to the planetary nebulæ are the sun-stars. These range in diameter from the " giant " sun of Orion, Betelgeux, with a diameter of $21 \cdot 5 \times 10^7$ miles, Arcturus $2 \cdot 1 \times 10^7$ miles, Sirius $0 \cdot 2 \times 10^7$ miles, our sun $0 \cdot 09 \times 10^7$ miles, to " dwarfs " of still smaller diameter. Despite the considerable range in size of the sun-stars, they appear to centre round the order 10^7 miles, and are thus approximately one hundred thousand times less than the planetary and diffuse nebulæ. The ratios of their sizes to those of the atom and electron (and nucleus) are 10^{20} and 10^{25} respectively. The fourth and fifth roots of these numbers are both 10^5. This ratio is thus common to spiral and planetary nebulæ, to planetary nebulæ and sun-stars, and to atoms and electrons.

Throughout the magnitudes cited appears this ratio of one hundred thousand or 10^5, or simple powers of it, such as 10^{25}, 10^{30}, 10^{35}. It applies to billions of known bodies in nature from the minute to the gigantic. It is too widespread to be due to mere coincidence. It has been indicated that it is the seventh root of the nebula-electron ratio, the sixth root of the planetary nebula-electron ratio, the fifth root of the star-electron ratio, and the first root of the atom-electron ratio. It would appear that to complete the series only three more stages are wanted, which would be given by 10^{10} times, 10^{15} times, and 10^{20} times the magnitude of the electron. The first of these three stages would thus have the magnitude 2×10^{-8} mile, 3×10^{-3} cm., or 30 microns. This is the order of size of *microscopic* things in general. The next stage would have the magnitude 2×10^{-3} mile, or 120 inches. The average height of man is 66 inches or 10^{-3} mile. This stage is consequently that of *macroscopic* things in general. The last of the three stages would have the magnitude 2×10^2 miles or 200 miles. This is the order of size of the geographical features of the planets, and also of the diameters of the asteroids, the planetary satellites, and the planets. This stage may be called the geographical (*ge*, the earth).

It thus appears that the universe is constructed in at least eight stages or tiers, each of which is related to the stage above or below by the common ratio of size 100,000 or 10^5. I suggest, by analogy with *myriad* (the Greek and Roman name for ten thousand) that this common ratio of magnitude in matter have the specific name *quiniad.* These eight stages are the electronic (and nuclear), the atomic (and molecular), the microscopic, the macroscopic, the geographical, the stellar, the planetary-nebular, and the spiral-nebular.

It is not without interest to observe that if the nebular size, 3×10^{17} miles be multiplied by this quiniad ratio, 10^5, the magnitude obtained is 3×10^{22} miles. This dimension, the ninth tier of matter, should be that of the universe, and it is perhaps more than a coincidence that this estimate is of the same order of size as the mathematician's dimensions of the universe. The relativity theory gives $1 \cdot 5 \times 10^{22}$ miles as the diameter of the original universe before expansion, while Eddington's calculation from nebular recession speeds gives a diameter of 20×10^{22} miles. A figure closer to Eddington's is obtained by multiplying the inter-nebular distance, 50×10^{17} miles, by the quiniad, giving 50×10^{22} miles, a dimension not far removed from the relativity estimate, 90×10^{22} miles for the diameter of the present universe in the early stages of expansion.

THE FUTURE OF SCIENCE IN CIVILIZATION*

In opening, Mr. Rhodes said that it was not possible to consider the future of science in civilization out of relation to the past and the present. It was true of the mediæval alchemists, as it was of the scientific men of the 17th century, that the aim of scientific research was a olution of the mystery of the universe and the problem f man's origin and destiny, but in the 18th century a rocess of splitting off had begun. Science drifted arther and farther away from philosophy. In the 19th century this process was complete and this had ad very important effects upon the development of the ndustrial revolution. There had been no philosophy f science worthy of the name, so that scientific men had ecome immersed in technical problems with very little egard to their effects upon society.

The challenge of the Marxian analysis.—Karl Marx vas born in 1818, and his philosophy had been persistntly misrepresented and misunderstood alike by friends nd enemies. His economic theory seemed, on the hole, to be unsound, but his interpretation of history as not; the process was being worked out much as he ad predicted. Marx was the philosopher whom science ught to have had. He predicted what was going to appen under a highly organized industrial and scientific egime, and all the indications were that what he said as coming true.

Capitalism.—Mr. Rhodes said that capitalism was process and not a thing, and it would pass, perhaps ery quickly, just as other processes had decayed or een violently overthrown. Capitalism was wrong only far as it looked as if it would speedily become unworkble. The time was coming, and many thought it had lready come, when a condition of slump had arrived om which industrial civilization could not recover.

It was the great opportunity of science to step in and ke charge. The conditions were, in fact, anarchic, owever peaceful they might appear on the surface. here were only two realities in the present situation: roduction and consumption. Governments no longer overned, but were the playthings of economic forces ver which they were fast losing the precarious control ey still pretended to exercise. No sudden crash was kely, but a slow and steady decay and corruption.

The paralysis of the scientific man, who at least saw early and was prepared honestly to face realities, was ue to the fact that he had no philosophy, which after ll meant nothing more than that in common with other eople he had no plan to live by, no belief in man's iture and destiny. That was a stain and a disgrace. Even in this eleventh hour the situation could be saved. cience had the ability and the knowledge; it lacked nly the will to act.

The problem arose as to how and through what it was act. After long consideration he had come to the onclusion that you could not say, "Everyone else has iled, why not try us?" and thus form a science arty. You had to act in harmony with the historic rocess or no one would follow you. There were only *three movements of any importance in this connexion, conservatism, Fascism, and communism. He thought that they could rule out conservatism because it was, on a last analysis, degenerative, but it was dangerous* because it was in the historic process. Both Fascism and communism were revolutionary, and both in essence were anti-capitalistic. He thought that, on the whole, the Fascist conception of the State was—although he disliked the word Fascism—more scientific than the communist. But what was required was a synthesis of the best elements in both. The scientific concept of the future would not be the Fascism of Mussolini—although there was a man as great as Lenin—nor that of the preposterous Hitler; it would be rather a new and scientific socialism resting upon economic and cultural standards which intelligent men already clearly understood but had up to now lacked the will to define in simple terms, to fight for if necessary, and to apply. When science recovered its philosophical standpoint these things would come abont.

But they had also to be prepared for the more immediate future. It seemed improbable, but the situation did contain elements which might in some circumstances precipitate a sudden catastrophe.

Capitalism was a necessary phase of social evolution, but it was failing after an incredibly short period of time—capitalism as we understood it, not being much more than a hundred years old—because it had no philosophy, and had developed no culture. Capitalism was barbarous and philistine, and it was going the way of all philistines. It even waged futile and disastrous wars, as did other barbarians, in an endeavour to escape from its economic difficulties.

The difficulty of building a new Britain and a new Europe was not due to the fact that people did not know what they wanted. It was rather that the issues were obscured by an instinctive adherence to formulæ which were utterly out of date. Once men's minds had been relieved of that bondage, the issues would stand out clearly, and the goal would be in sight.

* Lecture delivered by Mr. Henry T. F. Rhodes, Editor the *Chemical Practitioner*, before the British Association of emists and kindred societies at the Derby Technical College March 30th.

THE PURIFICATION OF CRUDE SALTPETRE*

By RASIK LAL DATTA, D.Sc.

Crude saltpetre as prepared by the "Nunias" from nitrous earth in the drier districts of Behar, the United Provinces, and the Punjab contains various impurities, chiefly sodium chloride which varies widely in different samples, ranging from 17% to 40% of the weight of crude saltpetre.

The existing process of obtaining commercial crystallized saltpetre consists in dissolving the crude saltpetre in hot water and crystallizing. The saltpetre thus obtained still contains considerable quantities of salt varying from 3% to 8%. It has been found possible by following the method to be described, to obtain a saltpetre which is almost pure containing not more than 0·25% to 0·35% of salt by means of a single crystallization of the crude saltpetre. The process is based on the fact that a solution saturated both with respect to potassium nitrate and sodium chloride will deposit on

* The main principle of the process has been patented in Ind. Pat. No. 6460, December 9, 1920.

cooling considerable quantities of potassium nitrate with only small quantities of sodium chloride since the solubility of sodium chloride increases to a small extent with rise of temperature whereas the solubility of potassium nitrate increases very much. 31 parts of potassium nitrate are soluble in 100 parts of water at 20° C. whereas 247 parts of potassium nitrate will dissolve in 100 parts of water at 100° C. and 36 parts of sodium chloride are soluble in 100 parts of water at 20° C. whereas they will dissolve only 39·8 parts at 100°. When such a solution saturated both with respect to potassium nitrate and sodium chloride at the boiling temperature is mixed with one-fifth of its volume of fresh water (or mother liquor obtained in the course of recrystallization to obtain highly pure potassium nitrate), the solution at once becomes unsaturated with respect to sodium chloride and cannot on cooling deposit any crystals of sodium chloride, whereas on account of the very great solubility of potassium nitrate at higher temperatures it will on cooling still deposit considerable quantities of crystals of potassium nitrate, the yield being about 20% less on account of the addition of one-fifth of its volume of water. The crystals of potassium nitrate which separate under such circumstances have been found to contain 0·25% to 0·35% of sodium chloride, if steps are taken to obtain small crystals by crystallizing in shallow tanks and to dry the crystals by means of the centrifugal machine.

The process is carried out on a large scale as follows. A saturated solution of the crude saltpetre is made by dissolving the crude saltpetre in boiling water. If the saltpetre contains much mud, it may be dissolved by dipping bags of saltpetre in boiling water when the mud will be left behind in the bag. It has been found convenient to dissolve crude saltpetre containing much mud in cold water, decant the clear saturated solution and then bring it to saturation in the hot by dipping bags of crude saltpetre containing less mud. The boiling of the hot saturated solution, usually having a density of 1·38, is continued and the salt which separates during the boiling should be removed by means of a ladle. The density of the solution gradually increases due to the increase of the strength of potassium nitrate in the solution. The salting should be continued till the liquor assumes a density of about 1·5 when a solution is obtained which is nearly saturated with respect to potassium nitrate and fully saturated with respect to sodium chloride; 20% of its volume of water (or mother liquor obtained in the course of preparing highly pure potassium nitrate) is added and the solution is allowed to crystallize in shallow tanks. The crystals of potassium nitrate are secured and made colourless by washing with small quantities of bleaching powder solution. The wash water may be conveniently used in lieu of pure water for adding to the solution before its crystallization. The small amount of calcium introduced thereby removes any alkaline sulphate that may be originally present in the crude saltpetre, being precipitated as calcium sulphate.

It has been found desirable to add very small quantities of potassium chloride depending on the quantities of sodium nitrate present to the original liquor during salting which will effect a decomposition of any sodium nitrate present so that a product is obtained which is pure potassium nitrate containing only 0·25% to 0·35% sodium chloride only and no sodium nitrate, as also no sulphate.

In the salting process the salt which separates in the early stage contains little or no potassium nitrate, while the salt which separates later contains some potassium nitrate. The salt which separates later should be dissolved in water and resalted, whereby pure salt is separated leaving the nitre in the mother liquor which should be added to fresh charges for salting.

CHEMICAL APPLICATIONS OF THE POLARIZING MICROSCOPE

By NORMAN H. HARTSHORNE

The value of the polarizing microscope to the chemist has been emphasized by several American writers, *e.g.*, Benedict (Ind. Eng. Chem., 1930, [Anal.], **2**, 91), who reported numerous instances of organic problems on which time and labour had been saved by the use of this instrument. The following examples, which have come within the experience of the author, also appear worthy of being placed on record.

(1) Some pure potassium mercuric iodide, $KHgI_3,1\frac{1}{2}H_2O$, was required. A sample submitted by a firm was examined under the microscope, when it was seen that, in addition to the yellow birefringent crystals of the complex salt, colourless isotropic crystals were present. These were suspected to be potassium iodide, which crystallizes in the cubic system and has a refractive index (D) of 1·667. The suspicion was confirmed by mounting the specimen in a liquid of refractive index 1·66, when the isotropic crystals were shown by the Becke test to have an index very slightly less than that of the liquid. The point to be stressed is that the impurity could not have been detected by qualitative chemical analysis, since in solution the complex salt gives potassium, mercuric, and iodide ions.

(2) A sample of "A.R." di-ammonium hydrogen phosphate received from a firm was very different in appearance from that already in stock, which was known to be satisfactory. The doubtful sample was tested chemically for ammonium and phosphate ions, and gave positive results, but its identity was not thereby proved, for it might have been one of the other ammonium phosphates. When compared under the microscope with the authentic substance however, both were found to be biaxial (the di-hydrogen salt, at least, is uniaxial), and readily gave single optic axial interference figures. β was found to be 1·51 in both cases. The identity of the two specimens was therefore confirmed.

(3) A specimen of ammonium di-hydrogen phosphate received from a firm was examined under the microscope for impurity. Most of the crystal fragments observed had one index equal to 1·525, which is the value for ω for this salt. A few, however, showed indices which were *both* less than 1·52, and moreover, gave biaxial figures. Their optic axial angle and β value showed them to be the diammonium salt. Here again, the impurity could not have been detected by qualitative chemical analysis.

The time consumed in making the above tests was in no case greater than half an hour.

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USE OF "TER MEER" TYPE CENTRIFUGAL SEPARATORS IN SALT WORKS

By R. W. MILLER

The use of centrifugal separators for extracting fluids and drying salts is widely known, their advantages being so evident that no specialist will deny them, even allowing for lengthy and successful experience with other types of apparatus. They are most frequently required for drying separated salts to a determined degree of humidity. The oldest and simplest process for this purpose employs heat after having removed as much of the moisture as possible. As the process by drying proves to be very expensive, apparatus has been developed to remove moisture by means of suction or centrifuging. Drying in this manner necessitates very little subsequent evaporation by means of heat, whilst in many cases it can be entirely dispensed with. The apparatus chiefly used in modern plants for the preliminary drying are so called suction strainers and centrifugal separators. Owing to their simplicity of design and operation, suction strainers have been introduced in

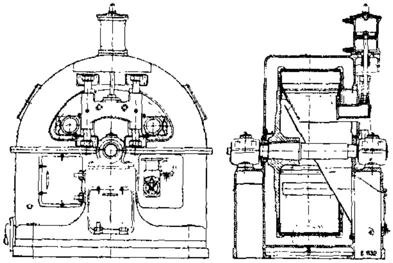


Fig. 1

Ter Meer centrifugal separator for fine-grain crystalline salts

many plants, although with the centrifugal separators a higher degree of dryness is attained. With the latest centrifugal separators of high capacity, output and simplicity of operation are as good or better than those of the suction strainers, whilst with types of equal capacity centrifugal separators are more economical owing to the fact that less heat is required.

That the saving may be considerable is shown by the following example: the figures refer to practical results obtained with a plant in which suction strainers are used, as well as centrifugal separators of the latest design, for the processing of the same product, a refined crystallized salt. The "Ter Meer" centrifugal separator used in the plant (Fig. 1) has been fitted with a special filtering apparatus, whereby it has been possible to attain a higher capacity and a higher degree of dryness as compared with the ordinary type of machine. In the particular case referred to it was necessary to dry salt at the rate of 17,000 lb. per hour. The degree of humidity of the dried salt was 5% when using a centrifugal separator and 12% with a suction strainer. The water content in 17,000 lb. of salt was therefore 900 lb. with a centrifugal separator and 2150 lb. with the suction strainer. Thus, when using the suction strainer 1250 lb. more water had to be evaporated.

The amount of heat necessary for the evaporation of one litre water is: for increasing the temperature from 68 to 212° F. 144 B.Th.U., for evaporation 949 B.Th.U.; total 1093 B.Th.U.

Thus the total amount of heat required for the centrifugal separator was $900 \times 1093 = 983{,}700$ B.Th.U. and for the suction strainer was $2150 \times 1093 = 2{,}250{,}000$ B.Th.U.

The saving of heat therefore with the centrifugal separator was 1,266,300 B.Th.U. If with the suction strainer 12·5 lb. of brown coal were used per 100 lb. for the proper drying of the salt, only about 4·8 lb. of brown coal had to be burned in order to dry the centrifuged salt. The saving of coal in the case of the centrifugal separator therefore amounted to $12{\cdot}5 - 4{\cdot}8 = 7{\cdot}7$ lb. per 100 lb. and with 17,000 lb. of salt $170 \times 7{\cdot}7 = 1209$ lb. of coal per hour was saved, thus representing a total annual saving, presuming 300 days of 24 working hours, of $1209 \times 24 \times 300 = 8{,}705{,}000$ lb. or 3917 tons of coal. Based upon a price for the coal of £1 per ton this is equivalent to an annual saving of £3917.

A further saving was attained by the smaller power consumption of the centrifugal separator. At the same output the power consumption of the suction strainer amounted to 75 b.h.p., whereas the power consumption of the centrifugal separator, including power absorbed by pump and automatic control gear amounted to an average of 35 b.h.p., *i.e.*, 40 b.h.p. less. Taking an average price of ½d. per b.h.p. the annual saving on account of lower power consumption amounted to £600.

A further considerable saving was effected by the reduction of washing necessary to reduce a 10% solution of an undesirable substance present down to 0·5%. With the suction strainer there was about 2150 lb. of this 10% solution, *i.e.* about 200 lb. of the injurious substance or about 1·3% of the 17,000 lb. of the salt produced per hour. With the centrifugal separator, there was only 900 lb. of this 10% solution, or 90 lb. of this injurious substance, or 0·53% of the hourly produce, so that a further washing was not necessary. These figures alone prove the considerable superiority of the centrifugal machine whilst it must further be taken into account that the maximum output of the centrifugal separator amounted not to 17,000 lb. per hour but to 22,000 lb. per hour.

The difference of capacity between the suction strainer and the centrifugal machine is, admittedly, not so large in all cases. With other salts similar tests have given the following results:

Humidity with suction strainer	Humidity with centrifugal separator
%	%
7	4·5
14	7·4
14—16	8—9

In spite of the very evident advantages of the centrifugal process, objections against them are sometimes still raised by experts. These objections may be attributed to the fact that in many cases centrifugal separators of old-fashioned design have been used

which were not capable of fulfilling a manufacturer's requirements. The rough working conditions which sometimes prevail in chemical works, the lack of thoroughly trained operating staff, and the continuous

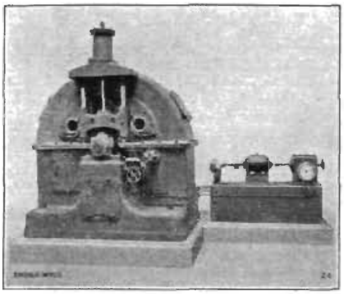


FIG. 2

Ter Meer centrifugal separator with automatic oil pressure control

operation of the machines and apparatus call for considerable reliability and quality of the plant employed. High capacity, simplicity of operation, and good general arrangement of the whole plant are necessary. The "Ter Meer" type of centrifugal separators has for a long time given every satisfaction as the only fully automatic centrifugal machine, and is now being built by Escher Wyss in various types to fulfil all practical requirements. Fig. 2 shows the latest design. The most interesting feature of this machine is the automatic oil-pressure control, which confers a number of advan-

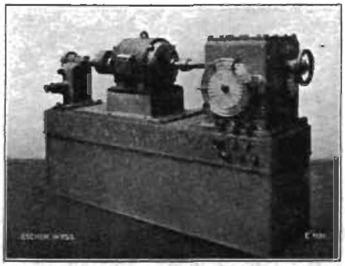


FIG. 3

Pressure oil control gear

tages. This special type of control gear (Fig. 3) consists of a pump, operating device, the actual control apparatus, and an oil container; the arrangement is simple and easy to supervize as all parts are accessible to the eye. The individual parts run entirely in oil, are therefore hardly subject to any wear and tear, and are, furthermore, easily accessible. The operation of the various working parts, for instance, for charging, washing, and emptying, is effected by servo motors. The latter are subjected to practically no wear and tear, and consequently no breakdown need be feared. In order to avoid all risk of stoppage owing to breakage of machine parts in case of sudden overloads which often occur in such plants, an adjustable safety valve, set to the required normal oil pressure (4—5 atm. gauge pressure), is inserted between pump and control gear.

The very accurate and regular working of the oil-pressure control and the sturdy construction of the various parts of the machine make reliability in operation greater than that of any other operating method. In comparison with entire and partial operation by hand the oil-pressure control offers not only the advantage of great reliability and reduced running costs,

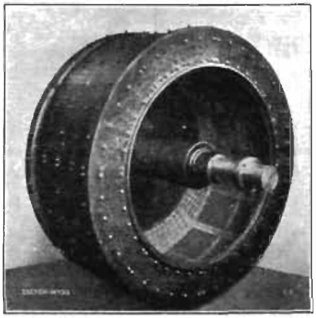


FIG. 4

Centrifugating cage

but also ensures the constant quality of the product. A disturbance frequently experienced in plants is the choking of the supply pipe, but in "Ter Meer" machines the oil-operated valves are designed so that choking cannot occur in any circumstances, whilst choking of the pipes can be avoided by proper arrangement of the valves. With these measures the machine is made entirely reliable in operation and adaptable to the different products to be treated. To ensure the smallest possible consumption of power, it is advisable to let the machine run through all operations at full speed, thus avoiding any losses due to braking and restarting. Losses of time between the various processes can be prevented by proper adjustment of the oil-pressure control.

Having dealt with the questions of easy supervision, reliability of operation, easy accessibility of parts, maximum capacity, low power consumption, and smallness of space required, attention may be turned to maintenance and interchangeability of strainer cloths.

It is hardly likely that any repairs have to be made on the control gear, servo motor or valves, since these parts are not subjected to any particular strain. Wear and tear of the bearing bushes can likewise be avoided by having these of generous dimensions. The simple design of all parts of the machine makes it possible to provide large doors and openings for erection and dismantling, so that the interior of the cage is easily accessible. The filtering area is divided into various segments, and it is possible to repair or exchange any parts of the strainer cloths. Fig. 4 illustrates the sturdy construction of the cage. Appropriate and robust construction of the machine eliminates vibration.

For some purposes a centrifugal separator fitted with scrapers cannot be used, since these injure some of the crystals, and for these particular working conditions Escher Wyss have designed a special machine.

A GENERAL CHEMICAL EQUATION

By W. HARRISON, M.Sc.

The recent work on the transformation of elements can be expressed by chemical equations of the type familiar to chemists, providing one uses suitable symbols embodying the two numerals which definitely identify an element, *i.e.*, atomic weight and atomic number. Thus for any element we can adopt a symbol A_xN_y where x and y represent the numerals of atomic weight and atomic number respectively.

According to this system the symbol for the hydrogen atom is A_1N_1, for helium A_4N_2, for oxygen $A_{16}N_8$, and so on. The neutron is A_1N_0 whilst the electron is A_0N_{-1}: the atomic weight of the electron is not exactly zero but is so small in relation to that of hydrogen that it may be neglected. The transformation of beryllium into carbon and neutron is expressed as follows: $A_9N_4 + A_4N_2 = A_1N_0 + A_{12}N_6$.

Similarly the transformation of lithium into helium can be expressed:

$$A_7N_3 + A_1N_1 = 2A_4N_2,$$

and nitrogen into an isotope of oxygen:

$$A_{14}N_7 + A_4N_2 = A_{17}N_8 + A_1N_1.$$

The same system can be applied to the radioactive transformations. Thus:

Uranium 1 to uranium X_1 $A_{238}N_{92} = A_{234}N_{90} + A_4N_2$
Uranium X_1 to uranium X_2 $A_{234}N_{90} = A_{234}N_{91} + A_0N_{-1}$
Uranium X_2 to uranium 2 $A_{234}N_{91} = A_{234}N_{92} + A_0N_{-1}$
Radium to radium emanation $A_{226}N_{88} = A_{222}N_{86} + A_4N_2$
Polonium to lead $A_{210}N_{84} = A_{206}N_{82} + A_4N_2$
Radium C_2 to lead $A_{210}N_{81} = A_{210}N_{82} + A_0N_{-1}$

In the last transformation the product must be an isotope of lead or radium C_2 must emit α rays as well as β rays, in which case the equation would become $A_{210}N_{81} = A_{206}N_{82} + A_4N_2 + 3A_0N_{-1}$. In all the transformations so far known one finds one of the elements A_0N_{-1}, A_1N_0, A_1N_1, A_4N_2.

The application of this system of symbols, whilst being valuable in the cases of transformation of elements would be somewhat complicated in ordinary chemistry and much more so in organic chemistry, but it is possible that it may prove helpful in explaining many points in both inorganic and organic chemistry.

MANLOVE, ALLIOTT & CO., LTD.

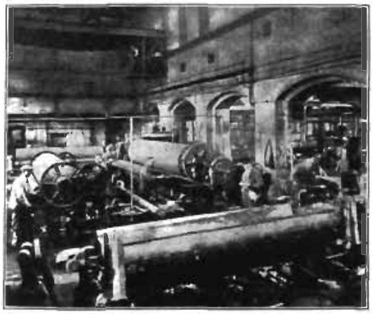
It happens very often, perhaps too frequently, that once the pioneer of an industry has indicated that a path exists which is worth following, he is jostled off the path by the anxious crowd that follows and overtakes him, and so gets little benefit from his early labours. Chemical engineering seems to provide an exception. On looking back in its history it is gratifying to note that some of the names first encountered are those prominent in the industry to-day. An excellent case in point is that of Manlove, Alliott & Co. Every chemical engineer knows the firm as manufacturers of centrifuges, rotary dryers, filter presses, and similar plant; perhaps not all of them know that the firm was the first to manufacture centrifugals in this country, for it was about a century ago that Edward Manlove and Alexander Alliott formed the Centrifugal Co. to manufacture hydro-extractors on the principles evolved by Seyrig, an engineer from the Continent. In 1837 the firm of Manlove, Alliott & Fryer was formed to take over the business, and so began the Bloomsgrove works at Radford, on the outskirts of Nottingham. The centrifuge was discovered to be suitable for sugar refining, a big laundering industry developed and needed to be supplied with hydro-extractors, ironers, and other machinery, and the chemical industry grew up with many and varied needs. Manlove, Alliott & Co. kept pace with the development, and so stand to-day in an enviable position. What the development has meant to the Bloomsgrove works we were able to judge during a recent visit.

Our first point of call was appropriately enough the foundry, for it is here that many machines have their beginnings. Amongst many casting operations going on a notable one was the formation of the hemi-cylindrical beds of "Decondons," or ironing machines, which are part of the equipment of every laundry. If perhaps a little off the beaten track of chemical industry these castings are not without general interest, being 25 ft. long and weighing six tons. In other parts of the works we saw similar decoudon beds being machined to a smooth surface, with an accurate alignment throughout the entire length expressed by a variation of less than 1/1200 in. To obtain perfect service in the ironing machine the beds are machined under the same conditions of heat and steam pressure as actually exist in the machine when in operation.

In the machine shops numerous parts were being prepared and finished and the erecting shops were busy with many types of plant familiar to the chemical engineer. Amongst the bigger plant were some rotary dryers such as we had seen in operation in beet sugar factories in this country. A point of interest was that almost all the massive plate work was being welded; soon, we suppose, the rivet will become definitely old-fashioned, if not the relic of a past decade in chemical engineering. Of other sugar manufacturing equipment being assembled the pressure leaf filter of rapid discharge type, which Manlove, Alliott & Co. have made a speciality, deserves mention.

Amidst the variety of constructional work going on two recent developments we noticed were of special interest. The first was the production of dry-cleaning

equipment, a completely self-contained unit for use with such solvents as trichlorethylene being of interesting construction. The material to be cleaned or degreased is placed in a perforated basket and rotated inside a container holding the solvent. When the solvent has done its work the basket is made to serve as a centrifugal for drying the material. The solvent is then circulated through an adjacent chamber holding several leaf filters, and is so recovered in a form which can be used again, whilst the leaf filters can easily be lifted out to clean. The second development in which Manlove, Alliott & Co. have specialized is the construction of hospital sterilizing equipment for the supply of sterile water and the sterilization of instruments in the operating theatre and similar situations. We watched one such equipment in stainless steel and Monel metal being erected to plan as it would appear in the operating theatre, and admired the attractive work and the careful construction.



View in the erecting shop

A department of some interest too was the experiment shop—a sort of miniature doll's house of industry, where industrial operations may be tried out on a laboratory scale. The shop contained a rotary drier no more than a yard or two long, filter presses in miniature, oil expressers, centrifugals, and many other pieces of factory equipment which seemed, after having seen the full-sized plant in construction outside, a little like playthings, but which can hardly be so described when they have provided many a manufacturer with information which could only otherwise have been obtained at the expense of full-scale trial and possible failure.

Much could be said in detail of many other parts of the works, for although the Bloomsgrove works has seen several generations of workmen come and go, it is in no way out of date; its equipment indeed, and its products would provide material for a much longer article, but when one endeavours to compress a hundred years of progress, and expansion to the extent of eleven acres, into the limitations of a column or two of print, one may perhaps be forgiven if the treatment is a little scanty.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

Annual General Meeting. Notice is hereby given that the annual general meeting of the Society will be held in Armstrong College, Newcastle-on-Tyne, on Tuesday, July 11, 1933, at 11 a.m.

The existing composition of Council was published in the JOURNAL of January 6. Dr. R. H. Pickard will retire from the office of President and Council has nominated Dr. J. T. Dunn to take his place for the year 1933—34.

The following vice-presidents will retire, viz.: W. A. S. Calder, H. Levinstein, F. L. Pyman, and H. Talbot. They are not eligible before the lapse of a year for election as vice-presidents or ordinary members of Council. Council has nominated in their places: J. B. Firth, F. A. Greene, R. H. Pickard, and Edwin Thompson.

The following four ordinary members of Council retire at the annual meeting and are not eligible for re-election: F. W. Bain, F. A. Greene, L. A. Jordan, L. H. Lampitt.

Nominations are invited of members to fill these four vacancies. They must be made on Form B, obtainable from the General Secretary, at 46, Finsbury Square, London, E.C.2. They must be signed by not less than five members and by the candidate, and must be posted to the General Secretary before June 5. No member may sign more than one nomination paper. Overseas members may secure copies of Form B on application to their local honorary secretary.

Index. The Index to Abstracts A and B in buff covers and the Index to CHEMISTRY AND INDUSTRY and Transactions in blue covers have both been distributed to every paid-up member or subscriber of 1932. If, in any case, the copies have not come to hand within one week of the appearance of this notice, a claim should be registered immediately with the General Secretary, Society of Chemical Industry, 46, Finsbury Square, London, E.C.2.

No claim for non-delivery can be considered if made after the lapse of three weeks.

MEMBERS ELECTED

April 21, 1933

Ainsworth, Arthur Nicholls, "The Lilies," Chaplin Road, Wembley, Middlesex. Chemist.
Anderson, Moira Teresa, 13, Monson Place, Queen's Gate, S.W.7. Chemist.
Babb, Alfred Thomas Symonds, 57, Chesilton Road, Munster Park, S.W.6. Analytical and research chemist.
Baker, Freda Irene, 16, Gledstones Road, W.14. Chemist.
Baker, Leslie Charles, 16, Gledstones Road, West Kensington, W.14. Chemist.
Barlow, Charles Gerald, The Hermitage, Fulmer Road, Gerrard's Cross, Bucks. Chemist.
Barron, Lionel Fitzgerald, 15, Hillbury Road, Tooting Bec Common, S.W.17. Chemist.
Bassett, Cecil Abell, 63, Bellevue Road, Ealing, W.13. Chemist.

Bilham, Philip, "Ryecroft," Cross Road, Tadworth, Surrey. Research chemist.
Bowen, *Edward Ackroyd*, c/o *Thomas Ness, Ltd.*, *Norwood* Tar Works, Dunston-on-Tyne. Tar distiller.
Brasher, Dora Mary, 52, Stamford Brook Road, W.6. Chemist.
Brooks, John Joseph Ablett, "Abbotsleigh," 16, Ballards Way, South Croydon, Surrey. Chemist.
Bryson, Herbert Courtney, The Laboratory, 84, Fetter Lane, E.C.4. Manufacturing chemical technologist.
Bushill, John Herbert, The Laboratories, J. Lyons & Co., Ltd., Cadby Hall, Kensington, W.13. Research Chemist.
Cakebread, *Sidney Harold*, "*Galmpton*," *Tilehurst* Road, Cheam, Surrey. Analytical chemist.
Casson, Charles Bernard, 13, Foster Road, Chiswick, W.4. Chemist.
Chapelle, Georges Maurice, c/o Lacerta, Ltd., Bara Mahal, Tollygunge, Calcutta. Merchant.
Clayson, Donald Herbert Frank, 20, Sefton Avenue, Mill Hill, N.W.7. Chemist.
Coulson, Donald Arthur, Bowater's Paper Mills, Ltd., Northfleet, Gravesend, Kent. Chemist.
Crang, Beatrice Alice, 46, Keswick Road, Putney, S.W.15. *Analytical chemist*.
Daw, E. B., 15, Woodgrange Avenue, Ealing, W.5. Chemist.
Dimmick, Gladys Irene, 98, Barons Court Road, W.14. Chemist.
Filmer, Dorothy F., 81, Darenth Road, Stamford Hill, N.16. Chemist.
Fuller, Charles Hubert Francis, 34, Tudor Close, Cheam, Surrey. Chemist.
Gregory, Melville, 27, Voltaire Road, Clapham, S.W.4. Chemist.
Greenaway, Leonard *Ernest*, 203, *Gunnersbury Park*, Ealing, W.5. Chemist.
Howley, Leonard Charles Edward, c/o British Enka Art Silk Co., Aintree, Liverpool. Assistant chief chemist.
Hugh, Wilfred Eynon, "Celyn," 47, Victoria Road, Stockton Heath, near Warrington, Lancs. Manager of Main Laboratory, Joseph Crosfield & Sons, Ltd., Warrington.
Isomura, Otomu, Tokyo-Japan, No. 261, Shirokane Sankcho, Shiba-ku. Chemical engineer.
Jenkins, W. J., Technical Department, Nobel Section, Stevenson, Ayrshire.
Jennings, Arthur D., 26, Innage Road, Northfield, Birmingham. Technical chemist, Messrs. Cadbury Bros., Bournville.
Jones, Frank Raymond, 21, Cambourne Avenue, West Ealing, W.13. Chemist.
Lee, O. *Martin*, c/o *Fraser & Neave, Ltd.*, *Singapore*, Straits Settlements. Manager branch factory.
Lishman, George Percy, Lambton Coke Works, Fence Houses, Co. Durham. Coke works manager.
Maunsell, Alicia Erskine, Dennistoun, Hillside Road, St. Albans, Herts. Analytical chemist.
McIntyre, Gordon, Imperial Oil Refineries, Ltd., Sarnia, Ontario, Canada. Chemist.
Norman, Peter James, 23, Chelwood Gardens, Richmond, Surrey. Research chemist.
Norris, Edward Frank, 16, Havelock Road, Bexhill-on-Sea, Sussex. Student (London-External).
Pirie, Douglas George, 36c, Upper Addison Gardens, W.11. Chemist.
Porter, Ronald Philip, Technical Department, Val de Travers Asphalte Paving Co., Ltd., Sun Wharf, Alvar Street, Deptford, S.E.8. Technical chemist.
Purser, *Ernest Grenville*, 37, Birchwood Road, S.W.17 Analytical chemist.
Radcliffe, Mabel Rose, 36, West Cromwell Road, S.W.5 Research chemist.
Rooke, Horace Samuel, 146, Princes Avenue, Gunnersbury Park, Acton, W.2. Research chemist.
Rudland, Daisy Agnes, 883, *Foleshill* Road, Coventry Analytical chemist.
Shaw, Marian, 26, Basing Hill, Golders Green, N.W.11 Librarian.
Smith, Reginald Francis, "Rosslyn," 25, Stirling Road Wealdstone, Middlesex. Analytical chemist.
Stroud, H. H., 17, Priory Avenue, Walthamstow, E.17. Chemist.
Stuart-Jones, Phyllis, 16, Dukes Avenue, Muswell Hill, N.10. Chemist.
Sylvester, Norman Darby, 90, Elm Avenue, Ruislip, Middlesex. Chemist.
Turnor, Francis John, 131, Amyand Park Road, Twickenham, Middlesex. Analytical chemist.
Vine, Margery, 21, Philbeach Gardens, Earl's Court, S.W.5. Chemist.
Waygood, W. A., 45, Northwick Avenue, Kenton, Harrow. Chemist.
Wescott, *Cecil Ernest Arnaud*, 65, *Oaklands Grove*, W.12. Analytical chemist.
Winton, Albert James (re-election), c/o Hunt Bros. (Castleford), Ltd., Castleford, Yorks. Works manager.
Wise, William Charles Alfred, 64, Pembroke Road, Kensington, W.8. Chemist.
Wood, Robinson Pearson, The London Co-operative Society, Ltd., The Laboratory, 161a, Bow Road, E.3. Chief chemist.

CORRESPONDENCE

SEWAGE TREATMENT AND DISPOSAL

SIR,—We notice in your publication of Friday, April 21, 1933, an article referring to a reputed new American process on the treatment and disposal of sewage by use of ferric sulphate.

We should like to draw your attention to the fact that we first initiated the ferric sulphate process over 30 years ago, and have been supplying to various sewage works situate in the home counties every day since.

There is one case in particular of a continuity of supply during the whole of the above-mentioned period in connexion with which the daily flow of sewage is 4,500,000 gallons, and the purification result is even better than that mentioned in your article, in fact, the resultant effluent has the appearance of spring water.

We are Sir, etc.,
F. W. BERK & Co., LTD.
J. KERSHAW,
Director

London, E.C.
April 24, 1933

A COLLOID CORRELATION PRINCIPLE

SIR,—Referring to the correspondence on Dusts, Smokes, Mists, and Fogs (cf. CHEM. & IND., Dec., 1932, pp. 1006, 1042, 1077), the extension of the principle of life tendency of particle size as applied to the disperse phase of aerosols to provide a means of classification has now been considered with regard to colloid systems in general, including all other types besides aerosols.

The result seems to be, taking the word "particle" for the sake of convenience to mean a unit member of

any disperse phase in no matter what colloid system, that life tendency of particle size is a general function of the physical state of the dispersion medium in any given colloid. Thus, where the dispersion medium is gaseous, life tendency of particle size has maximum scope. It may either proceed from smaller to larger, or larger to smaller, dependent on the nature of the disperse phase. Where the dispersion medium is liquid, life tendency of particle size has medium scope. It proceeds from smaller to larger with greater or less ease, dependent on the nature of the disperse phase. Where the dispersion medium is solid, life tendency of particle size has minimum scope. It is practically arrested, to what extent being again dependent on the nature of the disperse phase, but where at all existent moving unidirectionally from smaller to larger. These conclusions can be tabulated as follows :—

Indicating life tendency of "particle" size variation in colloid systems, with variation of dispersion medium physical state

Dispersion medium	Life tendency of "particle" size	Instances	
Gaseous	Maximum scope	Dusts (larger to smaller tendency) Smokes (smaller to larger)	
Liquid	Medium scope	Foams (smaller to larger) Colloidal emulsions (smaller to larger) Colloidal suspensions (smaller to larger)	
Solid	Minimum scope	Colloidally dispersed crystal inclusions Colloidally dispersed eutectics	Practically arrested

Whilst there are distinct variations in life tendency of particle size, call it *a*, within the same dispersion medium class dependent on the disperse phase in particular cases, these variations are dominated by the scope of the tendency applicable to the given dispersion medium. The tendency considered in every case is that which naturally asserts itself when artificial or mechanical means of compulsion are arrested. It is therefore the true natural tendency—after formation of the system—in each case.

If this generalisation is correct, then there is a relationship between life tendency of "particle" size and physical state or some dependent or condition thereof of the dispersion medium in all colloid systems.

The most likely cause of the variation of *a* with variation of dispersion medium physical state which suggests itself is molecular mean free path. In cases where *a* is a maximum, the m.f.p. of dispersion medium molecules is also a maximum. Where *a* is of medium value the m.f.p. of dispersion medium molecules is also of medium value. Where *a* is of minimum value, the m.f.p. of dispersion medium molecules is likewise a minimum.

In what way is m.f.p. of dispersion medium likely to operate as a controlling factor of *a* in any given colloid ? Consider the aerosols, dusts, and smokes, respectively. All particles in a smoke aerosol are subject to bombardment of the molecules of the dispersion medium, though brownian movement may only be observable with particles $< 10^{-5}$ cm. diameter. The additive effect of such bombardment is likely to be least compelling on the particles when the m.f.p. is greatest because the freedom of translational motion of the particles will be greatest. There will thus be a larger amphitheatre—as it were—where other forces (more closely representative of the particles themselves) can dictate either larger to smaller, or smaller to larger, particle growth as the case may be. In the case of a smoke aerosol the increasing direction will be taken under the action of these forces, and in the case of a dust aerosol the decreasing direction will be taken. The amphitheatre of operation will become more restricted under the influence of the lessened m.f.p. and more numerous molecular content of a liquid dispersion medium. This restriction seems to operate in a valvular sense in such cases, and the other forces determining *a* operate unidirectionally from smaller to larger. In the case of solid dispersion media the amphitheatre becomes relatively closed-in, and *a* becomes practically arrested. The relationship is similar to that which shows a solid body to be relatively rigid and discrete so that it needs no containing walls ; a liquid to be allowable of freedom, but on its uppermost surface ; a gas to require total enclosure, save that the order is inversed and the conditions are much more complex.

As regards the difference in intensity of operation of *a* as between different systems having the same dispersion medium this will be dependent on characteristics forming the detailed study of particular systems, which will also be related in turn to the varying m.f.p. of the molecules of the disperse phase units as that is balanced against the m.f.p. effects of dispersion media molecules as outlined above.

But in any case, there seems to be a definite correlation between physical state of dispersion medium in all colloid systems, and the life tendency of "particle" size of the disperse phase units which one has not met with before and which seems to confirm the importance of *a* for aerosols and indicate its extended importance to all colloid systems.

I am, Sir, etc.,

S. C. Blacktin

Sheffield

April 23, 1933

PERSONAL AND OTHER ITEMS

Viscount Leverhulme, who has served as president of the London Chamber of Commerce for two years, was re-elected at the annual meeting of the Chamber held on April 25.

We regret to record the death on April 22, at the age of 70, of Sir Henry Royce, the famous designer of internal-combustion engines. Sir Henry founded the firm of Royce, Ltd. in 1884, and in 1907 the Rolls-Royce company was established. He was created a baronet in 1930 in recognition of his distinguished service.

The University of Cambridge has appointed Dr. N. W. Pirie demonstrator in biochemistry for a period of three years.

Mr. W. C. Waghorne, director of Insulators, Ltd., has been elected chairman of the British Plastic Moulding

Trade Association in succession to Capt. W. T. Barber, and Mr. W. M. C. Norie, of Croydon Mouldrite, Ltd., has been elected vice-chairman.

We regret to record the death on April 3 of Mr. Thomas Clarkson, a member of the council and past-president of the Institution of Automobile Engineers. Mr. Clarkson was prominent for his work in developing the steam road vehicle, and was responsible for much of the development of the thimble-tube arrangement now extensively employed in waste-heat boilers. He was the author of a number of papers on metallurgical subjects.

Mr. R. C. H. Unwin, who has had considerable experience with Baker, Perkins, Ltd., and who has been for the last few years a director of C. S. du Mont, Ltd., has been appointed head of the food and chemical machinery department of Bratby & Hinchliffe, Ltd.

We regret to announce the death on April 18 of Prof. E. W. Hobson, F.R.S., Emeritus Professor, and formerly Sadleirian Professor of Pure Mathematics at Cambridge. Prof. Hobson was president of the mathematical and physical section of the British Association in 1910 and was Gifford Lecturer at Aberdeen University in 1921–22, when he took as his subject "The Domain of Natural Science." He was awarded the Gold Medal of the Royal Society in 1907 for his investigations in mathematics.

Dr. K. G. Emeléus, M.A., has been appointed to the Chair of Experimental Physics in the University of Belfast in succession to Prof. W. B. Morton.

Mr. A. B. Henshaw, a director of the Staffordshire Chemical Co. and the New Acid Co., Tunstall, left estate of gross value £28,228, with net personalty £27,546.

We regret to learn of the death recently of Mr. C. P. Merriam, a director of the British Xylonite Co., Ltd. since 1927. Mr. Merriam was 77 years of age and had a long association with the plastics industry.

Plastics Exhibition: Postponement of Lecture

Owing to unforseen circumstances Mr. Kenneth Chance finds himself unable to deliver his lecture "Plastics: Urea-formaldehyde Types and their Uses," on Wednesday, May 3, as published. It will now be given on Wednesday, July 5, at 4.30 p.m. in the Science Museum. This will probably be the last of the series, which with one exception take place every Wednesday at 4.30 p.m. and are free.

Trade Mark Legislation

In connexion with the appointment by the President of the Board of Trade of a committee to examine the question of alterations in the Trade Mark legislation in this country the Association of British Chemical Manufacturers has appointed a Trade Marks Committee to examine the question from the point of view of the chemical industry. In order to make the inquiry as comprehensive as possible the various bodies comprising the Federal Council have been approached and invited to nominate representatives to form a Joint Chemical Trade Marks Committee on the same lines as the Joint Chemical Patents Committee which was so successful in connexion with the recent alterations [in] the Patents and Designs Act. The following organiza[-]tions have accepted this invitation and appointe[d] representatives: Institution of Chemical Engineer[s], International Society of Leather Trades Chemist[s], Institute of Chemistry, Society of Chemical Industry, Society of Glass Technology, Society of Public Analyst[s] and The Oil and Colour Chemists Association, while othe[r] bodies are awaiting the next meetings of their council[s] in order to consider the invitation.

Dr. W. Callen has been appointed to represent th[e] Society on this Committee.

University of London

The Halley Stewart Laboratories of Physics Researc[h] of the University of London, at 30, Chesterford Gardens London, N.W.3, are to be formally opened by Lor[d] Rutherford on May 4.

Postponement of London University Lectures

Owing to an accident Prof. L. Ruzicka will be unabl[e] to deliver his lectures on "The High-Membered Carbo[n] Rings" and "The Constitution of the Polyterpenes," arranged to be given at University College on May [9] and 11.

Old Ashmolean Museum

The 250th anniversary of the Old Ashmolean Chemica[l] Laboratory and Museum at Oxford falls on May 21 thi[s] year, and the occasion is to be marked by a number o[f] meetings during the week May 20—26.

Manchester University Scholarships

The Manchester City Council is again offering a number of scholarships tenable in the Faculty of Technology of the University of Manchester. Successful candidates are required to follow a full-time course leading to the degree of Bachelor of Technical Science in the College of Technology and matriculation or its equivalent is an essential qualification.

For students who have been engaged in industry, and who have attended part-time day or evening classes, the scholarships are of the value of £100 per annum, while for students leaving secondary or central schools the value is £60. Both classes of scholarships are tenable for three years.

British Standard Specification

The British Standards Institution has just issued a new specification for asbestos cement pressure pipes, covering four classes of pipes ranging in diameter from 2 to 40 in. The uses to which the pipes in each class should be put are not defined, so that the purchaser may select that class of pipe most suited to his own particular need. The test pressures laid down correspond to those for British Standard Cast-Iron Pipes, and the minimum tensile strength of the material as determined by hydraulic pressure is specified at 2240 lb. per sq. in. In dealing with accessories and jointing materials care has been taken to draw up the specification so as not to hinder future developments.

Copies of this specification (B.S.S. No. 486—1933) may be obtained from the British Standards Institution, Publications Department, 28, Victoria Street, London, S.W.1, price 2s. 2d., post free.

Canadian Chemical Association Convention

The annual convention of the Canadian Chemical Association will be held this year at the University of Laval, Quebec, on June 7, 8, and 9, and the Association is looking forward to a very successful gathering. Full particulars will be published at a later date. In the meantime the general secretary of the Society will be glad to hear from any members who expect to be in Canada about the time of the Convention.

Diesel-Electric Train

A report on the working of the first regular Diesel-electric train in this country has been issued by the constructors, Armstrong, Whitworth & Co., Ltd. The train has travelled 50,000 miles without a hitch during a daily programme of 17 hours on the L.N.E.R. in North Yorkshire, and the total cost of fuel and lubrication was £166.

International Steel Tube Cartel

It is reported that the arrangements in connexion with the International Steel Tube Cartel have been extended until March 31, 1935. The cartel comprises an Anglo-Saxon group, which includes Great Britain, Canada, and the United States, and a group of the principal continental manufacturing countries.

World Power Conference

The World Power Conference opens in Copenhagen on Monday, June 26, continues in Stockholm where the proceedings will be inaugurated by the Swedish Crown Prince on Wednesday, June 28, at 2 o'clock and where all the technical sessions will take place, and concludes in Oslo on Saturday, July 8.

Research Fellowships

In co-operation with the State Bureau of Mines and Geology the Montana School of Mines of the University of Montana is offering several fellowships in geology, metallurgy, and ore dressing. These fellowships are open to college graduates who have had good scientific training in those sciences which are the foundation of the mineral industry, and who are especially qualified to undertake research work. Each fellowship carries a stipend of $500 and is for a period of ten months, beginning September 1, 1933.

Problems under consideration for the coming year include: equilibrium relations of sulphides; dispersion hardening of non-ferrous metals and alloys; electrodeposition of alloys; flotation; flocculation and dispersion; fine grinding. Applications with certified copy of college record, statement of professional experience, recent photograph, and references should be addressed before May 1, 1933, to A. M. Gaudin, chairman, Graduate Committee, Montana School of Mines, Butte, Montana.

Sugar Factory Plant

We learn that Messrs. W. J. Alcock & Co. of Calcutta have recently booked large contracts for sugar factory plant.

Indian Notes

Institute of Science, Bangalore.—Many tributes were paid to Dr. M. O. Forster, retiring director, when the staff and students presented him with a farewell address. Under the direction of Dr. Forster the Institute has seen remarkable expansion of every department and the instigation of research on many problems. As the result of increased facilities for research the number of students has risen from 59 in 1922 to 158 in 1933.

The meeting was presided over by Sir Mirza Ismail, Diwan of Mysore State. Dr. Forster expressed his regret on leaving the Institute after ten years' association, and mentioned his gratification that his place was being taken by such a famous scientist as Sir C. V. Raman. Following his retirement Dr. Forster is to take up his residence in Mysore, and will therefore remain in close touch with the activities of the Institute.

Jute cloth for road surfacing.—An interesting experiment involving the use of jute cloth in road surfacing has recently been tried in Calcutta by the Indian Jute Mills Association. The work was carried out by Messrs. McLeod & Co. with the co-operation of the Public Works Department of the Government of Bengal, on a stretch of the Strand Road, one of the most important thoroughfares in Calcutta. After being scraped and cleaned, the road surface was coated with bitumen and then laid with jute fabric. The fabric was then again coated with bitumen, covered with a layer of fine stone metal and rolled so that the upper coating of bitumen penetrated the cloth and formed a solid mass with the bitumen underneath; at the same time the stone chips adhered to the bitumen and fibre, producing the wearing surface. The stretch of road so treated is behaving exceptionally well and has retained a better appearance than another stretch of road which was built at the same time without the jute cloth.

Institution of Chemists (India).—In his presidential address at the fifth annual meeting of the Institution, recently held in Calcutta, Dr. E. Spencer said that chemical industries in India had not developed in a manner commensurate with the country's resources. The principal reasons for this were the interdependence of the different branches of the modern heavy chemicals industry. In many cases the waste material or by-product of one branch of the industry provided the raw material for another, and owing to this factor allied branches of the industry had tended to become grouped together. Such grouping obviously made it difficult for small undertakings to gain a footing even in India, but once a start was made further progress should become less difficult. India was still a long way from supplying its own industrial requirements, but with their natural advantages an era of prosperity was ahead for industries in India.

German Manufactured Steel Exports

Exports of manufactured steel goods from Germany during 1932 totalled 79,082 cwt., a decline of more than 27,000 cwt. compared with the previous year. The figure for 1932 is the lowest recorded since the mark was stabilized in 1924, whilst it is 30,000 cwt. below the figure for 1913.

Correction

In our issue of March 24 a statement was made that the Nichols Medal for 1933 was awarded to Dr. Wilder D. Bancroft. This statement is incorrect; there will be no award of the Nichols Medal for 1933.

REVIEWS

PHYSICAL CHEMISTRY. *By Dr. J. Eggert. Translated by S. J. Gregg, Ph.D. Translation of the 3rd ed. of "Lehrbuch der Physikalischen Chemie," revised in collaboration with Dr. L. Hock. Pp.* 632. London: Constable & Co., 1932. 24s.

This volume is based on the 3rd edition (1931) of Prof. Eggert's well-known "Lehrbuch der physikalischen Chemie"; the original German text has been revised slightly, an introduction by Dr. Caspari has been added, and the bibliography has been modified to include only books in the English language. The subject matter is divided into three main groups, viz., atoms and energetics, the nature of matter, and chemical reactions, and the two last-named are subdivided in turn into sections entitled atoms, molecules, and states of aggregation, and chemical equilibrium, thermochemistry, electrochemistry, chemical kinetics, and photo-chemistry, respectively. From this outline it will be appreciated that the field covered is very wide, and indeed it may be said that every important aspect of the subject is dealt with. The treatment is exceptionally well balanced. Not only are the more simple aspects of physical chemistry dealt with in a clear and direct manner, but recent developments also are presented most lucidly, so that the book can be strongly recommended both to the student approaching the subject for the first time and to those who have been unable for one reason or another to keep in touch with the extraordinary rapid growth of the past few years and who wish to become more familiar with recent work.

The book is obviously not written for the uncritical reader who desires merely to be "spoon-fed"—even if such a method were possible with a subject which, in certain aspects at least, is in a constant state of flux—but presents its subject matter in a manner which invites the reader to endeavour to adjudge for himself the validity of present-day hypotheses.

Prof. Eggert is to be congratulated on having reduced to a readable account the welter of mathematical symbolism into which modern physical chemistry has appeared, at least to those of us who are primarily chemists, to have been drifting during recent years. To the translator also commendation is due, for teutonisms appear to be entirely absent and there is none of the "awkwardness" frequently to be found in a translation.

The book does not bristle with the multitudinous references to original papers which sometimes occupy far too much space in text books. The system adopted is to give, in the text, the name of the author to whose work reference is made, followed by the year in which the relevant paper was published; a note suggests that, if further details are required on any particular point, the author's name should be looked up in the index, for the year quoted, to one or the other of the abstracting journals. In this way a far greater number of references than would otherwise have been practicable have been included. The principle might with advantage be adopted more generally. Needless, perhaps, to add, the printing and binding are excellent, and the book offers very good value for its relatively modest price.

H. F. GILLBE

AN INTRODUCTION TO CHEMISTRY. *By Prof. F. I Kenrick. Pp. viii + 434. Toronto: Universit* of Toronto Press, 1932.

This is an excellent book, singularly logical an displaying much accuracy of thought. It gives a very careful account of the nature of mechanical mixtures, solutions, pure substances, the elements, the periodic system, and such topics. It is too carefully written and too difficult to appeal to most schoolboys as a first introduction to chemistry, but anyone who has even a very slight acquaintance with the science will get much benefit from this book and can learn from it many things that are described with greater care than is to be found in the average text-book. It is not the sort of book to assist in the rapid assimilation of chemical facts for examination purposes, but is the sort of book much needed as an antidote to the ordinary cramming literature.

AUSFÜHRLICHES LEHRBUCH DER ORGANISCHEN-CHEMIE. By Wm. Schlenk and E. Bergmann. Vol. I. Pp. viii + 805. Leipzig and Vienna: F. Deuticke, 1932. Unbound, 36 m. Cloth, 39 m. Half leather, 41 m.

There are text-books in plenty, both in English and in German, from which the student beginning chemistry can take his choice, but in the opinion of the two authors of this book there is need for a work to help him in the next higher stage of his studies, presumably before the pupil begins to read the specialist monographs which are so valuable a feature of our modern literature. Accordingly they have produced a book in which stress is laid on the general relationship of the facts of organic chemistry to one another, in which it is sought to capture the spirit of this branch of chemistry, stressing in addition its connexion with physical science on the one hand and biological science on the other. The book thus forms both a supplement and a contrast to the famous Richter, which seniors have seen developed from the most modest of beginnings to its present swollen size, and which deals with the individual compounds and reactions specifically.

This, the first volume, follows the usual division of the subject into aliphatic and aromatic compounds, and contains only the former section. Its contents comprise hydrocarbons and their halogen derivatives, alcohols, ethers, and esters, with vitamins sandwiched in between, amines, aldehydes and ketones, fatty acids, fats, and such special headings as suffice to embrace other aliphatic substances. Lastly, sections are devoted to sugars, to the proteins and to enzymes. No reviewer can criticize such a book in detail; it should take a couple of years' work for any student to master its contents. Chemistry has grown so far that no student can expect to master more than a tithe of it: indeed, the setting of alternative questions in honours examination papers shows that this fact is realized by the teacher. It becomes all the more necessary to have a book available from which one can glean with the minimum of trouble a working knowledge of at least most sections of the field. From this point of view it will be welcomed by older men who seek to keep pace with knowledge, as well as by the student of to-morrow.

COMPANY NEWS

THE BRITISH DRUG HOUSES, LTD.

At the annual general meeting of The British Drug Houses, Ltd. (financial results cf. CHEM. & IND., April 14, p. 333) held on April 12, the chairman and managing director, Mr. Charles A. Hill, said that the company's export trade had shown a substantial move forward during the past year, in spite of the disabilities imposed by the Import Duties Act, 1932, which was a factor operating to the company's disadvantage. A development was the formation of The British Drug Houses (Australia), Ltd., whilst the reorganization of the management of the Canadian subsidiary company, The British Drug Houses (Canada), Ltd. was already reflected in signs of better progress. The company had also made considerable headway in its South American markets. Mr. Hill pointed out that the company's medical specialities were widely known and were increasingly prescribed year by year. The sales of the company's principal vitamin products, Radio-Malt and especially Radiostoleum, continue to expand, last year's sales showing an increase over 1931 and exceeding all records.

Dr. F. H. Carr, C.B.E. stated that the B.D.H. policy was to make full and wide use of new methods and knowledge in order to provide the best and most efficient service to its customers. To-day that policy was shown more clearly than ever to have been a wise one. Past expenditure on equipment and scientific and technical research was bearing fruit to-day and even in these times of depression the company was continuing to sow for the future.

BABCOCK & WILCOX, LTD.

The directors of the company, manufacturing water-tube boilers and other heavy machinery, have announced a dividend of 3% less tax, and a distribution of 1½% actual out of profit realized on the sale of investments. This brings the total distribution to 9%, as compared with 14% last year.

STEWARTS AND LLOYDS, LTD.

The accounts of the company show a net profit during 1932 of £272,022, as compared with £317,272 in 1931. The sum of £152,029 has been placed to depreciation, and with £137,119 brought forward the available total is £257,111. After provision for preference dividends a balance of £156,738 remains to be carried forward. A new valuation has been given to the Northamptonshire ironstone properties in view of the fact that it is considered to have enhanced following the decision to proceed with the erection of new plant at Corby.

I. G. FARBENINDUSTRIE

The report of the combine states that the turnover during 1932 showed a further reduction and business was below the average of the previous year. The bottom of the depression was apparently reached in the second and third quarters, an upward movement being visible in the final quarter. The main difficulties are stated to be due to the world economic crisis and its effect on currencies, together with the subsequent tariff barriers erected by foreign countries. The directors have recommended a dividend of 7%, the same as last year, on the ordinary shares. The combine's holding of its own shares has been increased by Rm. 5,000,000. The total ordinary capital, on which dividend will be paid has thereby been lowered to Rm. 680,000,000, equivalent to £34,000,000 at par.

MARKET REPORT

This Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

The following alterations in prices are reported since the publication of the last Market Report (cf. CHEM. & IND., April 7, 1933, p. 311).

GENERAL HEAVY CHEMICALS

Calcium Chloride, Solid, 70/75%.—Spot, £5 5s. per ton d/d station in drums.

Soda Ash, 58° E.—Spot, £5 17s. 6d. per ton, f.o.r. in bags, special terms for contracts.

TAR PRODUCTS

Acid Carbolic.—Crystals—9d.—10d. per lb. Crude 60's, 1s. 11d.—2s. per gal. 2% water—3s. 0½d. per gal.

Creosote.—B.S.I. specification, 2½d. per gal., d/d. Heavy—4d. per gal.

Pitch, medium, soft.—85s.—90s. per ton, in bulk at makers' works.

Toluole.—90%, 2s. per gal. Pure, 2s. 4d. per gal.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Cinchophen.—11s. 6d.—12s. 6d. per lb.

Ephedrine hydrochloride.—5s. 6d.—6s. per oz.

Phenacetin.—4s. 6d.—4s. 9d. per lb.

Potass. Bitartrate.—99/100% (Cream of Tartar), 80s. per cwt., less 2½%.

Tartar Emetic B.P.—3s. 9d.—4s. 6d. per lb.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number. *Australia:* Bichromate of soda and potash, calcined anhydrous glauber salts, titanium potassium oxalate, titanium oxide, and hydrosulphite of soda (556). *Egypt:* Paper (B.X. 7546). *Holland:* Chemicals, chemical products and mineral oil products (576). *South Africa:* One steam turbine-driven centrifugal pump (G.X. 12,480); Two steam turbine-driven centrifugal pumps (G.X. 12,479); Steel (G.X. 12,491).

British Aluminium Co., Ltd.

The telephone number of the London warehouse of The British Aluminium Co., Ltd., at 25—29 Pancras Road, N.W.1, has been changed to Terminus 5301—2.

New Ultra-violet Research Cabinets

During recent years ultra-violet research in industry has developed considerably in scope and importance and two new "Microid" ultra-violet cabinets produced by Griffin & Tatlock, Ltd., Kemble Street, Kingsway, London, will be of interest to many research workers, as they provide highly efficient apparatus at moderate prices. In one, costing £14 14s., a twin "Ultrasol"

mercury vapour lamp unit is contained in an amply ventilated housing of sturdy and pleasing design. Below the housing is the observation chamber, with a detachable panel, enabling large surfaces, *e.g.*, pictures, fabrics, etc. to be examined through the available aperture. Curtains are provided to exclude unfiltered light during tests. In the second cabinet, costing £12 12s., a powerful tungsten lamp of new design is used, fitted with a quartz-type bulb. The inspection chamber in each case is of ample dimensions, and the cabinets, which are of reinforced metal, are light and easily transportable.

A Laboratory Lamp

A reliable source of artificial light that approximates to daylight is becoming more and more essential in industrial and other laboratories, where routine examinations are made depending on magnification of small objects, and colour comparisons have to be made with accurate discrimination. For some examinations indeed, daylight itself cannot always be relied upon, for there is a deal of difference between direct morning sunlight and, for example, a white north skylight. The G.V.D. Artificial Daylight Unit is therefore of considerable interest. This is claimed to give an accurate colour-matching light and at the same time a good one for general purposes, with the elimination of the eye-strain coming from the "glare" of ordinary artificial light. By the use of the lamp, conditions of examination are standardized, with results consequently more reliable. Its spectral distribution curve can be varied to resemble noon sunlight, overcast north skylight, or blue north skylight. It is supplied as a pendant unit or complete with an adjustable stand for the bench. Particulars can be obtained from G.V.D. Illuminators, Aldwych House, Aldwych, W.C.2.

Modern Bread Baking

Two recent issues (Nos. 227 and 228) of "A Thousand and one Uses for Gas" (British Commercial Gas Association, 28, Grosvenor Gardens, Victoria, S.W.1) provide much interesting information concerning the uses of gas in the bakery. One London firm has 14 gas-fired conveyor-type ovens, each baking 12,000 rolls of bread per hour; the booklets describe also a number of installations in the Newcastle area.

Rubber in Road Construction

A Digest of Patents dealing with Rubber and/or Latex in Road Construction, which has just been issued by the Rubber Growers' Association, 2—4, Idol Lane, Eastcheap, London, should be of considerable use to those who require a handy book of reference to the patent literature on this subject, which is continually growing in importance. The book has been prepared by Mr. Sidney Morgan, A.R.C.Sc., on behalf of the Technical Research Committee of the Association, and is divided into sections dealing with such subjects as preparation of bituminous emulsions, compositions containing latex plus bitumen, etc., and an alphabetical index is provided. The book will be forwarded free of charge to those who are interested.

Pulverizing and Emulsifying Plant

A very detailed and informative description of pulverizing plant is given in a booklet published by the British Rema Manufacturing Co., Ltd., Halifax. The booklet sets out the considerations affecting the selection of pulverizing machines and gives a detailed description of the operation of a complete plant. The diagrams and illustrations are particularly straightforward and easy to follow. Constructional details and special features of the feeding devices on the British Rema equipment are explained and the booklet deals also with ball mills, tube mills, rings and all pulverizers, and auxiliary equipment. British Rema equipment has been specially developed for firing water tube, Lancashire and marine boilers with pulverized fuel on the unit principle, and possesses many unique patented features. The grinding mills and classification equipment described in this catalogue are, however, applicable to the efficient grinding of many other substances besides fuel.

The company has also issued leaflets dealing with its continuous and batch type wet mixers and emulsifiers, for preparing chemical foods, creams, pastes, sauces, liquid meat extracts, pharmaceutical mixtures, etc., and the explanatory details will be found useful by manufacturers of such products.

PUBLICATIONS RECEIVED

WHEATS OF COMMERCE. By E. A. Fisher, M.A., D.Sc., and C. R. Jones, B.Sc., Ph.D. Technical Education Series. I. GENERAL CONSIDERATIONS. Pamphlet No. 9. November, 1932. Pp. 51. II. COMMERCIAL WHEAT CLASSES. Pamphlet No. 10, March, 1933. Pp. 52—104. London: National Joint Industrial Council for the Flour Milling Industry. 6d.

PHYSICO-CHEMICAL METHODS. By J. Reilly, M.A., D.Sc., and W. N. Rae, M.A. With a Foreword by F. G. Donnan, M.A., D.Sc., LL.D., F.R.S. 2nd ed., revised. Pp. xv + 822. London: Methuen & Co., 1933. 42s.

STEREOCHEMIE: EINE ZUSAMMENFASSUNG DER ERGEBNISSE, GRUNDLAGEN UND PROBLEME. Edited by K. Freudenberg and Others. No. 8. Pp. 1117—1276. Leipzig and Vienna: F. Deuticke, 1933. 18 m.

HYDROGEN ION CONCENTRATION AND ITS PRACTICAL APPLICATION. By F. L. La Motte, W. R. Kenny, and A. B. Reed. Pp. vii + 262. London: Baillière, Tindall, and Cox, 1932. 20s.

GROUNDNUT AND ITS USES. By A. K. Menon, B.A. Pp. 18. Madras: Government Press, 1932. 2 annas.

SIMPLE METHODS OF REFINING OILS. By A. K. Menon, B.A., and O. S. Menon, B.A. Department of Industries, Madras. Bulletin No. 36. Pp. 14. Madras: Government Press, 1932. 3 annas.

ANNUAL REPORT OF THE CENTRAL NARCOTICS INTELLIGENCE BUREAU OF THE EGYPTIAN GOVERNMENT, for the Year 1932. Pp. xvii + 170. Cairo: Government Press, 1933.

REPORT OF THE WATER POLLUTION RESEARCH BOARD FOR THE YEAR ENDED JUNE, 1932. With Report of the Director of Water Pollution Research. Department of Scientific and Industrial Research. Pp. iii + 55. London: H.M. Stationery Office, 1933. 1s.

FIFTY-FIFTH REPORT OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, FOR THE YEAR 1931. State of Connecticut. Public Document No. 24. Pp. xii + 850. New Haven: Published by the State, 1931.